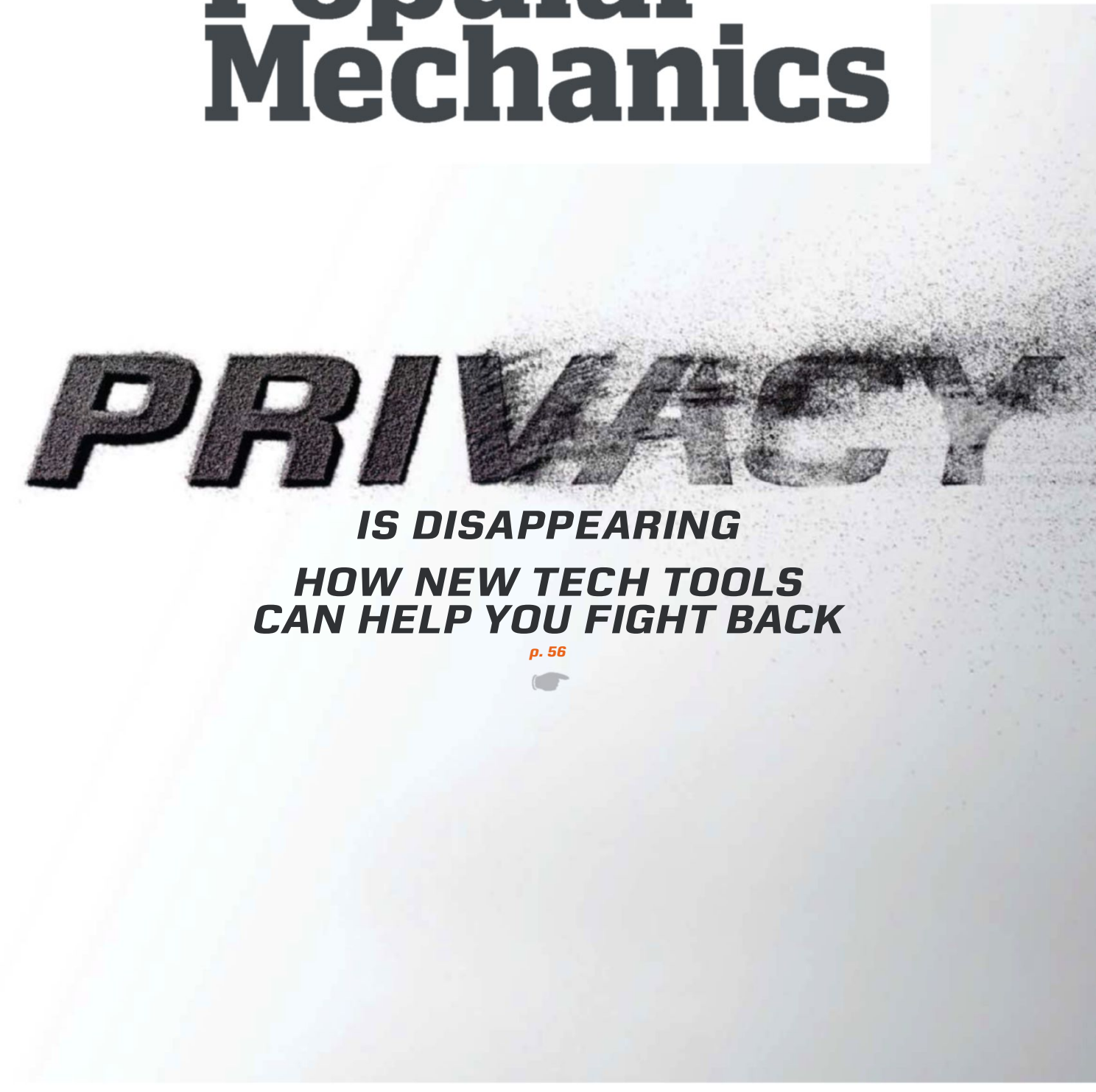
TOP TECH TRENDS FOR 2014 p. 52 HUMAN-POWERED FLIGHT p. 72

Popular Mechanics



IS DISAPPEARING

HOW NEW TECH TOOLS CAN HELP YOU FIGHT BACK

p. 56

INVISIBLE SKYSCRAPERS (yes, really) p. 19
THE NEW WAY TO INVENT p. 48
OLYMPIC GEAR SECRETS p. 64

TECH HOME AUTO ADVENTURE SCIENCE

ISSUE FEBRUARY 2014
Since 1902

WE DIDN'T JUST MAKE A CAR.

WE MADE HISTORY.



THE 2014 Mazda6 WITH SKYACTIV® TECHNOLOGY

Popular Mechanics AUTOMOTIVE EXCELLENCE AWARDS 2014

2014 *POPULAR MECHANICS* AUTOMOTIVE EXCELLENCE CAR OF THE YEAR

The Mazda6 with SKYACTIV® TECHNOLOGY isn't just another car. It's an entirely new kind of car. Built from the ground up using a series of breakthroughs that have completely overhauled more than a century's worth of conventional wisdom. SKYACTIV® TECHNOLOGY is our holistic approach to reengineering every component of the automobile for the ultimate in efficiency and performance. It's why the Mazda6 is *Popular Mechanics'* Car of the Year. And it's why every Mazda designed with SKYACTIV® TECHNOLOGY continues to win award after award. When you dare the impossible, you create the incredible. This is the Mazda Way. What do you drive?

BEST IN CLASS EPA-ESTIMATED 40 HWY MPG; STARTING AT $20,990†*

MazdaUSA.com

zoom-zoom

mazda

*Based on EPA estimates for 2014 Mazda6 Grand Touring models with Technology Package 28 city/40 highway MPG. Actual results will vary. SOURCE: Preliminary 2014 Fuel Economy Guide, October 23, 2013 (www.fueleconomy.gov).
†Starting at $20,990. MSRP plus $795 destination (Alaska $840) for 2014 Mazda6 Sport with manual transmission. 2014 Mazda6 Grand Touring model shown with Technology Package, $32,075 MSRP plus $795 destination (Alaska $840). MSRP excludes taxes, title and license fees. Actual dealer price will vary. See dealer for complete details.

PopMech



Icarus Cup entrant Clive Davidson pedals John Edgley's V-shaped aircraft at England's Sywell Aerodrome.

It's Time to Fight for Your Privacy 56
Your credit cards, smartphone, even your car are collecting your data. How can you protect your privacy? Here are 14 steps to take now. **BY DAVEY ALBA**

Margin of Victory..... 64
For Olympians, victory is measured in milliseconds. Introducing the tech that will help give the U.S. team an edge over the competition.
BY MICHAEL FRANK

The Improbable Flying Machines of Sywell ... 72
David Barford not only designed his airplane, he's also the engine. PopMech goes inside the quirkiest competition in aviation. **BY JEFF WISE**



11

NASA's LADEE moon explorer reimagines space communication with its lunar laser.

Ignition 04
Letters, Complaints, Events
Tech Watch 11
News, Trends, Breakthroughs
Upgrade 23
Gear, Tools, Gadgets
Auto Intel 35
Test Drives, Top Tech, Hot Rides

Columns

Inventors, Inc. 48
Startup Quirky uses the wisdom of crowds to help inventors turn ideas into products. BY CHRIS RAYMOND

10 Tech Terms for 2014 52
The trends and ideas you'll need to know this year.
BY ALEX HUTCHINSON



We drove this! p. 43

WEEKEND

Tech 82
Think you know everything about email? We debunk conventional wisdom and add tips and tricks of our own.
Digital Clinic This month we solve a camera conundrum and other tech problems.

Home 88
Build a concrete bench with our plans from rock-solid craftsman Eric Weil.
Tool Test Ten-inch compound miter saws do the job.
Home Clinic Roof looking rough? Assess the damage.

Auto 96
As electric cars multiply, so do the chargers that power them up. Here's everything you need to know to keep your chariot juiced and ready to roll.
Car Clinic Potholes plague our autos; repair the damage.

104 **A Brief History of the . . . Tunnel**
One thing Babylonians and Canadian drug runners have in common.



ON THE COVER

Prop stylist Sarah Guido used metal shavings and magnets to create the cover; photographed by Teru Onishi.



WHEN YOU'RE A WINTER OLYMPIAN, **THERE ARE NO SICK DAYS OR NIGHTS.**

The non-drowsy, stuffy head, sore throat, coughing, aching, fever, seize the day even with a cold...medicine.



The nighttime sniffling, sneezing, coughing, aching, fever, so you can sleep with a cold...medicine.

VICKS DAYQUIL & NYQUIL POWERFUL 6-SYMPTOM COLD & FLU RELIEF

Read each label. Use as directed. Keep out of reach of children.

© Procter & Gamble, Inc., 2014.

Official Sponsor of the Olympics. 36 USC 220506

VICKS® *breathe life in*™

TALK TO US



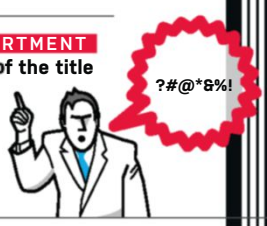
Email
popularmechanics@hearst.com

Snail mail
300 West 57th St.,
New York, NY 10019

Subscribe
subscribe.popularmechanics.com
1-800-333-4948

COMPLAINTS DEPARTMENT

The "mechanics" part of the title is getting buried in electronics.
PATRICK MASTERS, FAIR PLAY, S.C.



WHAT YOU SAID
(ABOUT OUR NOVEMBER ISSUE AND MORE)

We read all your comments, tweets, and letters. Here are some of the best from the mailbag, answered with care. *Curated by Darren Orf*

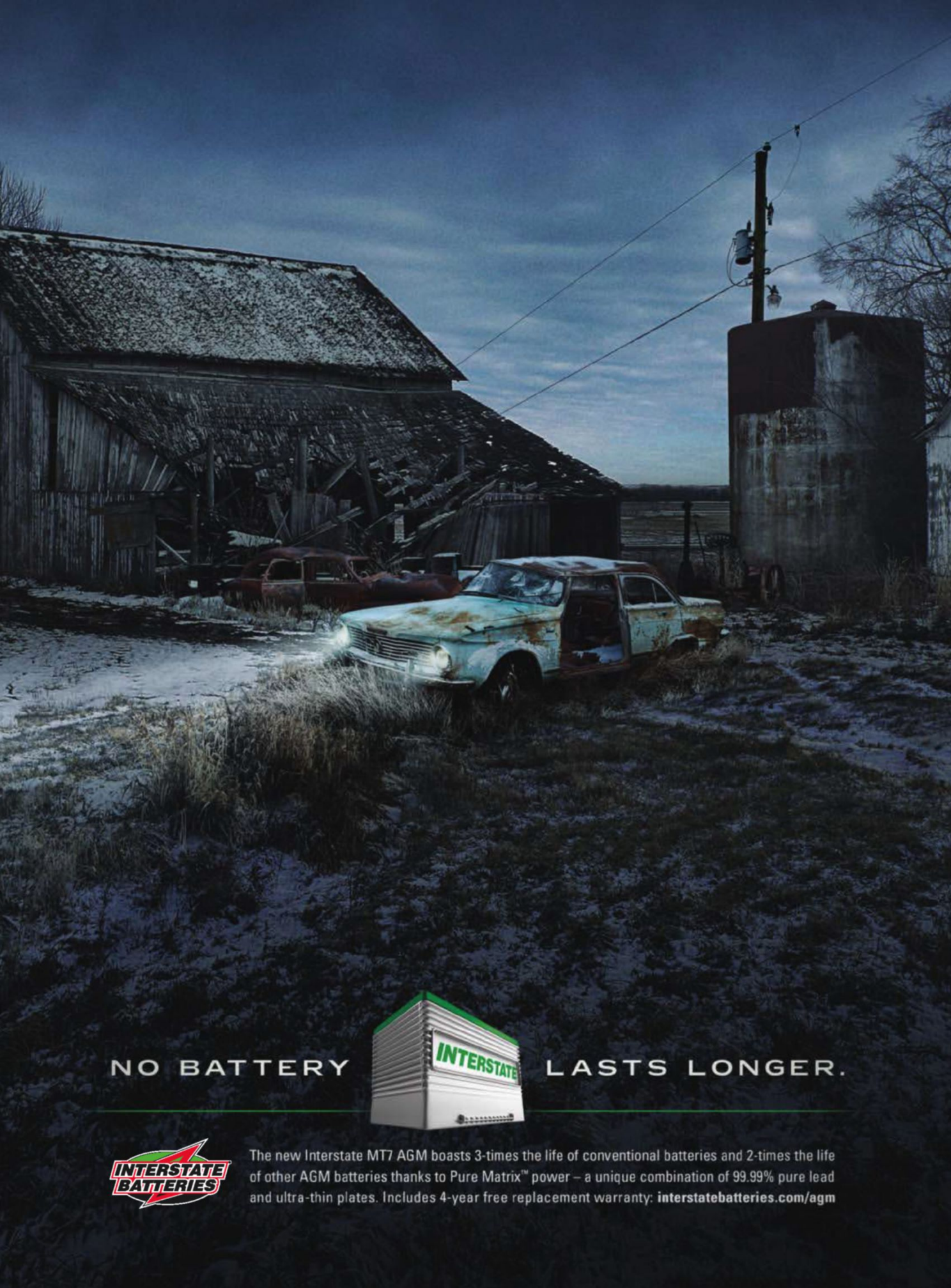
With features on innovators and next-gen tech, Arizona's tragic Yarnell Hill fire, and the sometimes dangerous hunt for space rocks, the November issue gave readers a lot to think about. ● Many of you applauded the picks for our 9th Annual Breakthrough Awards, from networked micro-UAVs to the Leadership Award winner. "I'm delighted to see that X Prize founder Peter Diamandis is so optimistic about the future relationship of humans and technology," writes Frank Heppner of Wakefield, R.I. "However, he might want to see *WALL-E*—the humans devolved into bloated, spineless pets." Okay, but, just to be clear, we all know that was a *movie,* right? ● Many readers commented on "Line of Fire," our coverage of the wildfire near Yarnell, Ariz., that killed 19 firefighters. "Your article on the killer fire was great," writes Steve Shaver of Seattle. Others were put off by the story: "The tenor of the article took a sour turn, placing blame on the residents," writes Marjorie Rodgers of Phoenix. ● Google built barges to show off its new tech, as we explain in our popmech.com story, "The Mystery of the Google Barge, Solved." Some readers weren't convinced. Eugene Kravtsov comments via Facebook: "I'm sure it is part of some Bond-villainesque scheme; Google is in your interwebs, reading your things." This is technically true, Eugene. But the jury is still out on whether Google's snooping is pernicious. We're keeping tabs (see "Privacy," p. 56).

WHAT WE'RE UP TO
(POPMECH NEWS & EVENTS & STAFFERS ON THE SCENE)

Military robots are reporting for duty. *Senior news editor Joe Pappalardo* witnessed a Marine squad's field introduction to the LS3, a robotic mule designed to carry supplies in the field. *Senior automotive editor Michael Austin* and *associate editor Andrew Del-Colle* visited SEMA 2013 in Las Vegas, combing the convention floor for new products for PM's Editor's Choice awards. *Special projects editor Joe Bargmann* indulged his chainsaw obsession with the mighty 18-inch Husqvarna 445, using his wood-removal permit in New York's Tallman Mountain State Park to harvest ash, oak, and birch for home heating.

WE'RE REALLY BUSY IN FEBRUARY

FEB. 5: 17th Annual FAA Commercial Space Transportation Conference; Washington, D.C. • **FEB. 8:** 2014 Chicago Auto Show • **FEB. 17:** Global Innovation Summit; San Jose, Calif.


NO BATTERY
INTERSTATE
LASTS LONGER.
INTERSTATE BATTERIES
The new Interstate MT7 AGM boasts 3-times the life of conventional batteries and 2-times the life of other AGM batteries thanks to Pure Matrix™ power – a unique combination of 99.99% pure lead and ultra-thin plates. Includes 4-year free replacement warranty: interstatebatteries.com/agm

SINCE 1902

JAMES B. MEIGS
EDITOR-IN-CHIEF; EDITORIAL DIRECTOR, MEN'S ENTHUSIAST GROUP

EXECUTIVE EDITOR **David Dunbar**
DESIGN DIRECTOR **Michael Lawton**
DEPUTY EDITOR **Jerry Beilinson**
MANAGING EDITOR **Michael S. Cain**

Editorial
SENIOR EDITOR, AUTOMOTIVE **Michael Austin**
SENIOR EDITOR, HOME **Roy Berendsohn**
SENIOR EDITOR, NEWS **Joe Pappalardo**
ASSOCIATE EDITORS **Jennings Brown, Andrew Del-Colle**
ASSOCIATE EDITOR, HOME **David Agrell**
ASSOCIATE EDITOR, TECHNOLOGY **Davey Alba**
COPY CHIEF **Robin Tribble**
RESEARCH DIRECTOR **David Cohen**
ASSISTANT TO THE EDITOR-IN-CHIEF **Theresa Breen**
WEST COAST EDITOR **Ben Stewart**
SPECIAL PROJECTS EDITOR **Joe Bargmann**
EDITORIAL INTERN **Will Dietrich-Egensteiner**

Art
SENIOR ART DIRECTOR **Peter Herbert**
ASSOCIATE ART DIRECTORS **Kristie Bailey, R. Scott Wells**
INTERACTIVE DESIGNER/ILLUSTRATOR **Anthony Verducci**

Photography
DIRECTOR OF PHOTOGRAPHY **Allyson Torrisi**
ASSOCIATE PHOTO EDITOR **Devon Baverman**

Editorial Board of Advisers
Buzz Aldrin (APOLLO 11 ASTRONAUT)
Shawn Carlson (SOCIETY FOR AMATEUR SCIENTISTS)
David E. Cole (CENTER FOR AUTOMOTIVE RESEARCH)
Saul Griffith (OTHERLAB)
Thomas D. Jones (NASA ASTRONAUT)
Dr. Ken Kamler (MICROSURGEON)
Gavin A. Schmidt (NASA GODDARD INSTITUTE FOR SPACE STUDIES)
Amy B. Smith (MIT)
Daniel H. Wilson (ROBOTICIST)
Wm. A. Wulf (NATIONAL ACADEMY OF ENGINEERING)

Senior Correspondents
Davin Coburn, Alex Hutchinson, Erik Sofge, Logan Ward, Jeff Wise
PYROTECHNICS & BALLISTICS EDITOR **William Gurstelle**
MYTHBUSTING EDITORS **Jamie Hyneman, Adam Savage**
GARAGE PROPRIETOR **Jay Leno**
RESIDENT CONTRARIAN **Glenn Harlan Reynolds**

Production
ASSISTANT MANAGING EDITOR **Natalie Neusch**

Imaging
DIGITAL IMAGING SPECIALIST **Ken Pecca**

PopularMechanics.com
ONLINE DIRECTOR **Angela Diegel**
ONLINE EDITOR **Andrew Moseman**
ONLINE PRODUCER **Carl Davis**

Popular Mechanics Interactive
PRODUCER **Jeff Zinn**

Contributing Editors
Andrew English, John Galvin, Jim Gorman, Chris Grundy, Carl Hoffman, John Pearley Huffman, Dan Koeppel, Fred Mackerodt, Joe Oldham, Barbara S. Peterson, Elizabeth Svoboda, Kalee Thompson, Joseph Truini, James Vlahos, Basem Wasef, Kevin A. Wilson, Barry Winfield

Contributing Photographers & Illustrators
Chris Buck, Jamie Chung, Philip Friedman, Christopher Griffith, Dennis Kleiman, Martin Laksman, Mark Mahaney, Axel de Roy, Dan Saelinger, Sarah Shatz, Vladimir Shelest, Josh Simpson, Art Streiber, Dan Winters, Reed Young

Special Projects Team
Tova Carlin, Annette Deinzer, Jack Dylan, Sarah Fecht, Darren Orf, Paula Rackow, Alyson Sheppard, Janet Stafford, Katrina Zook

MICHAEL KUNTZ
PUBLISHER

NATIONAL DIRECTOR, INTEGRATED SALES **Estee Cross**
EXECUTIVE DIRECTOR, GROUP MARKETING **Lisa Boyars**
FINANCE DIRECTOR **Don Perri**

Integrated Marketing
SENIOR MARKETING DIRECTOR **Barbara Serino**
CREATIVE DIRECTOR **Glen Fuenmayor**
ART DIRECTOR **George Garrastegui, Jr.**
MARKETING DIRECTOR **Jason Graham**
ASSOCIATE MARKETING DIRECTOR **Bonnie Harris**
SENIOR MARKETING MANAGER **Amanda Luginbill**
ASSOCIATE MARKETING MANAGER **Kirsten Kubiak**
MARKETING COORDINATOR **Anna Chelak**

Administration
ADVERTISING SERVICES DIRECTOR **Regina Wall**
ADVERTISING SERVICES COORDINATOR **Aiden Lee**
EXECUTIVE ASSISTANT TO THE PUBLISHER **Ilona Bilevych**

Digital
NATIONAL DIGITAL ACCOUNT MANAGER **Cameron Albergo**
MANAGER **Amanda Marandola**

Production
GROUP PRODUCTION DIRECTOR **Karen Otto**
GROUP PRODUCTION MANAGER **Lynn Onoyeyan Scaglione**
ASSOCIATE PRODUCTION MANAGER **Karen Nazario**

Circulation
CONSUMER MARKETING DIRECTOR **William Carter**

Advertising Sales Offices
NEW YORK
ACCOUNT MANAGER **Stephen Acunto, Jr.** 212/649-2902
ACCOUNT MANAGER **Alex Gleitman** 212/649-2876
ASSISTANT **Jennifer Zuckerman** 212/649-2875

LOS ANGELES
CALIFORNIA SALES MANAGER **Anne Rethmeyer** 310/664-2921
ACCOUNT MANAGER **Amy Suprenant** 949/610-0458
INTEGRATION ASSOCIATE **Michelle Nelson** 310/664-2922

CHICAGO
MIDWEST DIRECTOR **Spencer J. Huffman** 312/984-5191
ACCOUNT MANAGER **Rikka Runyon** 312/251-5355
ASSISTANT **Yvonne Villareal** 312/984-5196

DETROIT
REGIONAL DIRECTOR **John Irvine** 248/614-6120
ASSISTANT **Toni Starrs** 248/614-6011
HEARST MAGAZINES SALES, LLC

DALLAS
Patty Rudolph 972/533-8665 PR 4.0 MEDIA

DIRECT RESPONSE ADVERTISING
SALES MANAGER **Brad Gettelfinger** 212/649-4204
ACCOUNT MANAGER **John Stankewitz** 212/649-4201

CLASSIFIED ADVERTISING REPRESENTATIVE
Kathleen Gleason 888/473-0788; FAX: 708/352-4094 KLASSMARK

SENIOR VICE PRESIDENT & PUBLISHING DIRECTOR, MEN'S GROUP **Jack Essig**
GROUP MARKETING DIRECTOR, MEN'S GROUP **Jill Meenaghan**

PUBLISHED BY
HEARST COMMUNICATIONS, INC.

Steven R. Swartz PRESIDENT & CHIEF EXECUTIVE OFFICER
William R. Hearst III CHAIRMAN
Frank A. Bennack, Jr. EXECUTIVE VICE CHAIRMAN

HEARST MAGAZINES DIVISION

David Carey PRESIDENT
Gilbert C. Maurer PUBLISHING CONSULTANT
Michael Clinton PRESIDENT, MARKETING & PUBLISHING DIRECTOR
Mark F. Miller PUBLISHING CONSULTANT
John P. Loughlin EXECUTIVE VICE PRESIDENT & GENERAL MANAGER
Ellen Levine EDITORIAL DIRECTOR



THE KID WANTS TO KNOW

Are you a kid with a question? Ask Darren!

Email popularmechanics@hearst.com.

Could a Snapdragon 800 processor have enough power to serve as a computer's CPU? *Nathan B., 11, Boerne, Texas*

The short answer is yes, says Michelle Leyden Li, a Qualcomm spokeswoman. The MacBook Pro Retina with an Intel Core i7 chipset clocks in at 2.3 gigahertz, the same as the postage-stamp-size Snapdragon 800. — *DARREN ORF*

NISSAN

Innovation that excites

THE ALL-NEW VERSA® NOTE.™ YOUR DOOR TO MORE.™

When it comes to doing what you love, more is better. That's why we designed the all-new Nissan Versa Note to let you put your passions first, with best-in-class interior volume,[1] 40 MPG highway[2] and tons of new and useful technology, including a 360° Around View® Monitor.[3] No wonder *Popular Mechanics* just gave it their 2014 "Best in Value" Award. There's a lot to love about it.

Versatile Interior | Unexpected Technology | Fuel-Efficient

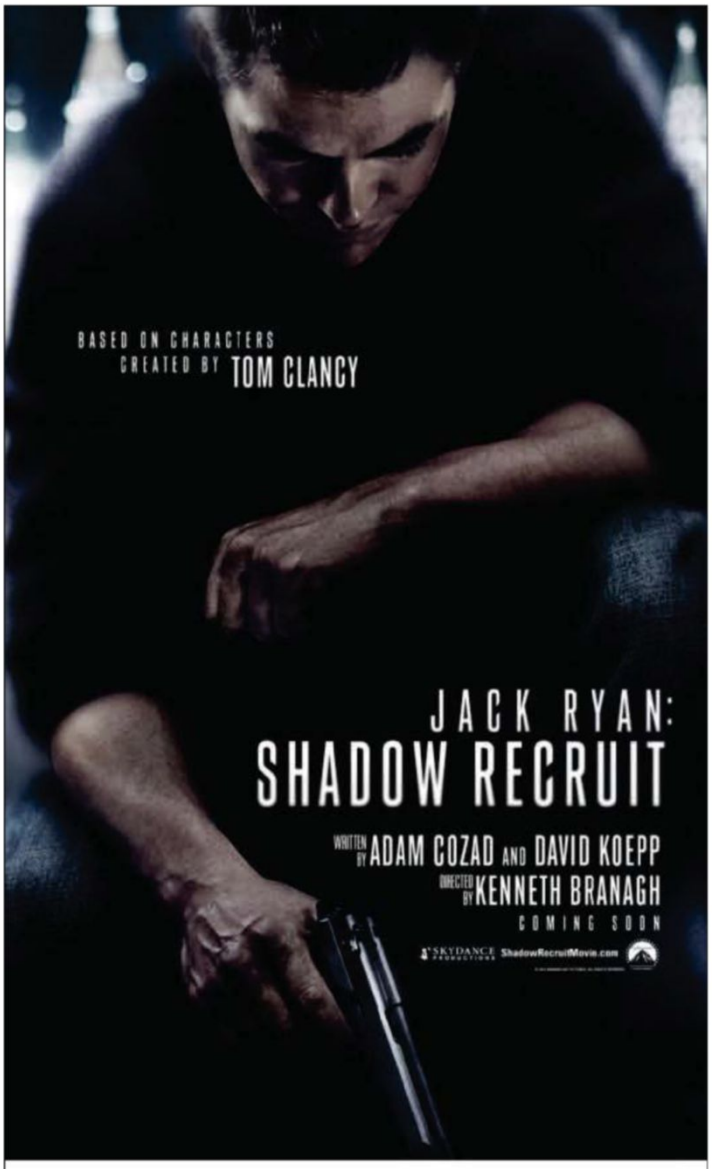


Popular Mechanics AUTOMOTIVE EXCELLENCE AWARDS 2014

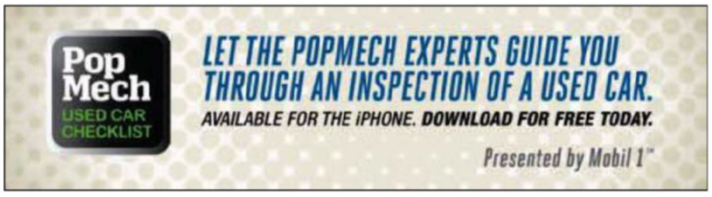
[1]AutoPacific segmentation. MY14 Versa Note vs. 2013 Economy Compact class, 5-passenger vehicles, excluding electrics and hybrids. [2]2014 EPA fuel economy estimate, 40 MPG highway for Versa Note with CVT. Actual mileage may vary – use for comparison only. [3]Available feature. Parking aid/convenience feature. Cannot completely eliminate blind spots. May not detect every object and does not warn of moving objects. Always check surroundings before moving vehicle. Not a substitute for proper backing procedures. Always turn to check what is behind you before backing up. Always wear your seat belt, and please don't drink and drive. ©2014 Nissan North America, Inc.

PopMech | IGNITION / ON THE WEB

AUTOMOTIVE SCIENCE TECHNOLOGY HOME HOW-TO CENTRAL VIDEO



IN THEATERS JANUARY 17TH
ShadowRecruitMovie.com



POPULARMECHANICS.COM

On popmech.com find the most intricate Rube Goldberg machines, look back to just after the big bang, and read these great stories:



3D-PRINTED CAR

In 2015 two brothers hope to drive Urbee 2, a lozenge-shaped car made mostly by 3D printing, across the U.S. Meet the future of car manufacturing.
popularmechanics.com/urbee

EARTH POWER

Take a tour of a remarkable geothermal plant, where Iceland turns the earth's heat into usable energy.
popularmechanics.com/icelandenergy

ROBOT MULE

PopMech heads to the woods of Massachusetts to join the Marines on their first day testing a surprisingly lifelike robotic mule.
popularmechanics.com/ls3

GET $10 ON iTUNES

WHEN YOU SUBSCRIBE TO PM ON THE IPAD

Each month the editors of Popular Mechanics create a special tablet version of the magazine that features all of our print content, plus extra photos, video clips, and classic stories from our archives. And right now we're running a sweet little promotion just for iPad users.

- ***Subscribe here: deal.popularmechanics.com***
- ***You'll get: PopMech for iPad, plus $10 on iTunes***

FOLLOW POPMECH

For plenty more from our editors, follow Popular Mechanics on:
Twitter
@PopMech
Facebook
facebook.com/popularmechanics
Tumblr
popmech.tumblr.com

Idle *to* Redline.

Change for the better.
Switch and you could save with GEICO.

geico.com | 1-800-947-AUTO | local office

GEICO®



Some discounts, coverages, payment plans and features are not available in all states or all GEICO companies. GEICO is a registered service mark of Government Employees Insurance Company, Washington, D.C. 20076; a Berkshire Hathaway Inc. subsidiary. GEICO Gecko ©1999-2014. © 2014 GEICO

WeatherTech®

Automotive Accessories

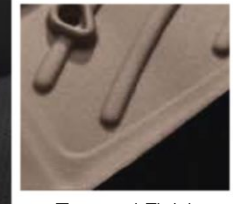


Laser Measured, Custom-Fit

FloorLiner™



Accurately and Completely Lines the Interior Carpet



Textured Finish



Contoured Underside



Available in Black, Tan and Grey for over 900 Applications

Check out our full line of Automotive Accessories at WeatherTech.com



All-Weather Floor Mat



Cargo/Trunk Liner



Side Window Deflectors

Accessories Available for

Acura · Audi · BMW · Buick · Cadillac · Chevrolet · Chrysler · Dodge · Ferrari · Ford · GMC · Honda · Hummer · Hyundai · Infiniti
Isuzu · Jeep · Kia · Land Rover · Lexus · Lincoln · Maserati · Mazda · Mercedes-Benz · Mercury · Mini · Mitsubishi · Nissan
Oldsmobile · Plymouth · Pontiac · Porsche · Saab · Saturn · Scion · Subaru · Suzuki · Toyota · Volkswagen · Volvo · and more!

Order Now: 800-441-6287

American Customers
WeatherTech.com

Canadian Customers
WeatherTech.ca

European Customers
WeatherTechEurope.com

© 2013 by MacNeil IP LLC

Tech WATCH

NEWS
TRENDS
BREAKTHROUGHS

Edited by
JENNINGS BROWN

1

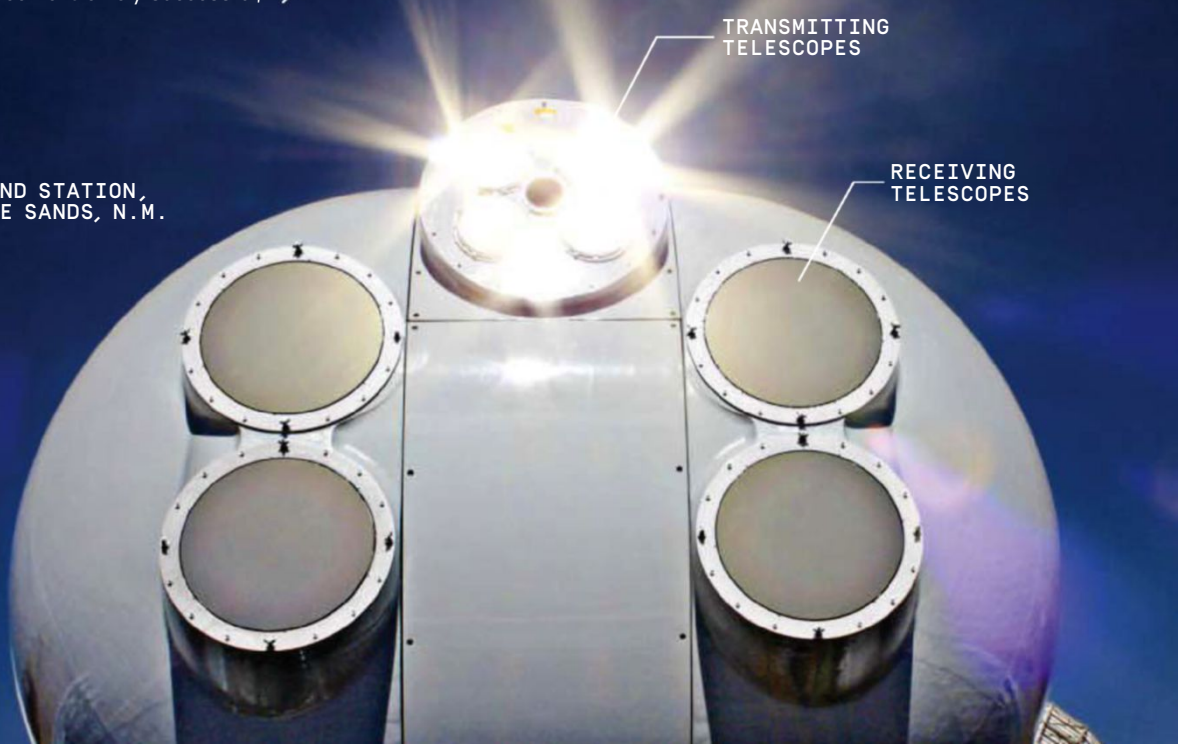
Lunar Laser

AN EXPERIMENT AROUND THE MOON HERALDS THE NEXT GENERATION OF SPACE COMMUNICATIONS.

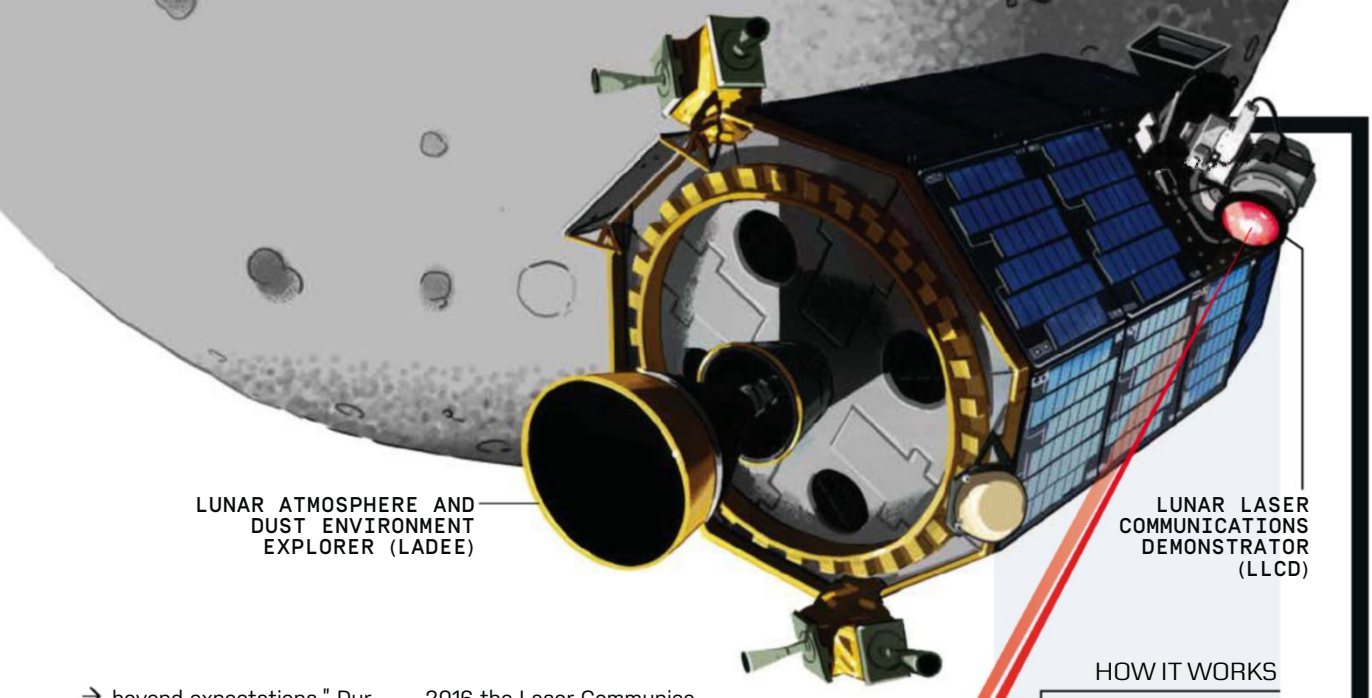
BY JOE PAPPALARDO

The future of space communications may come at the speed of photons instead of radio waves. Researchers for the first time have communicated with a spacecraft using a laser system.

In late October the Lunar Laser Communications Demonstrator (LLCD) beamed data at 622 megabits per second—orders of magnitude faster than the current rate—back from the spacecraft, which was in lunar orbit. Don Cornwell, mission manager at NASA's Goddard Space Flight Center, said that the LLCD "has been extremely successful, →



PHOTOGRAPH BY ROBERT LAFON/NASA



→ beyond expectations." During the test the LLCD sent a string of binary code from the satellite orbiting the moon to a ground station in New Mexico. It was the fastest download rate between the moon and Earth. For scale, NASA says that the spacecraft that's carrying this laser experiment would take 639 hours to download an average-length HD movie using the standard S-band radio. LLCD could download the same film in less than 8 minutes.

The next step for laser space communications will occur closer to home. In 2016 the Laser Communications Relay Demonstration (LCRD) will hitch a ride into space on a communications satellite, where it will orbit Earth. In 2017 the LCRD will begin beaming 1.25 gigabits per second of test information from a ground station to the satellite and back to Earth to another ground station. The test spacecraft will be in orbit for two to five years, operating 24 hours a day, to prove the system is robust enough for commercial use. If it is, the test could open up new avenues of big-data-information exchange at the speed of light.

HOW IT WORKS

1 **READY**
The spacecraft positions itself in the moon's orbit so the Lunar Laser Communications Demonstrator (LLCD) points at Earth.

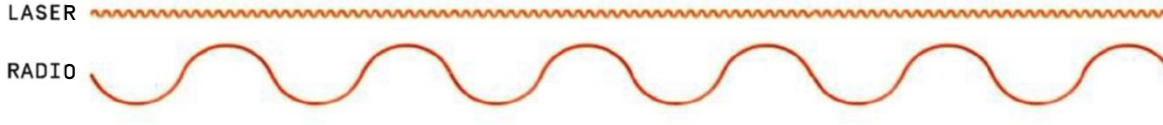
2 **AIM**
An onboard detector scans for a signal from the ground terminal, telling LLCD where to aim its laser.

3 **FIRE**
A 4-inch laser beam travels 238,000 miles from the spacecraft orbiting the moon to White Sands, N.M. Coded test information is transmitted at 622 megabits per second.



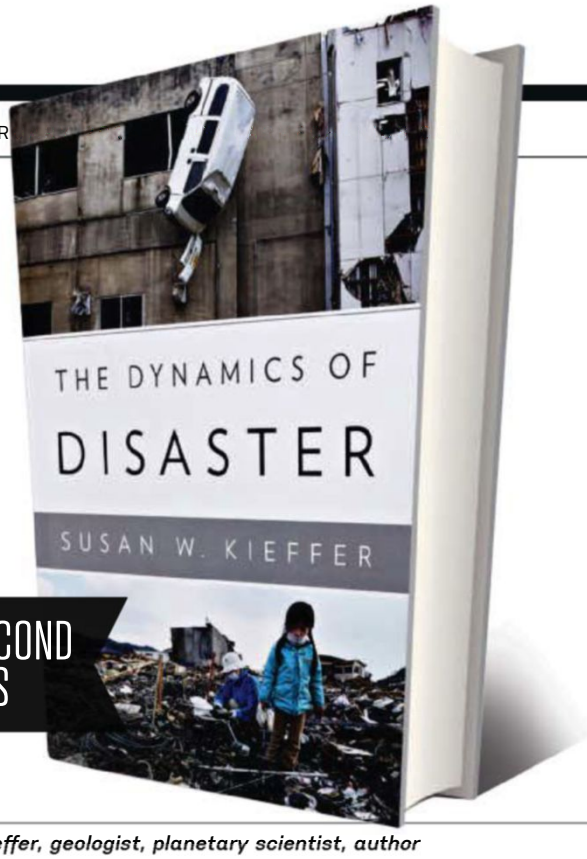
WHY LASERS?

Laser wavelengths are 10,000 times shorter than radio wavelengths, delivering much more data than even the best modern radio system yet using less power. On the ground, collecting antennas can be smaller, easier to build, and cheaper to maintain.



ILLUSTRATIONS BY MACKENZIE SCHUBERT


Red Bull
ATHLETE: KIRBY CHAMBLISS | CAPTURED BY: KIRBY CHAMBLISS
HERO3+
BLACK EDITION
HERO3+
GoPro
Be a HERO.
GoPro App
Control. View. Share.
Wear it. Mount it. Love it.™
49 ACCESSORIES AND COUNTING
See more at gopro.com



60-SECOND GENIUS

Susan Kieffer, geologist, planetary scientist, author

IN HER BOOK, *THE DYNAMICS OF DISASTER* (W. W. NORTON & COMPANY), KIEFFER EXPLAINS WHAT VARIOUS LARGE-SCALE NATURAL DISASTERS HAVE IN COMMON AND DESCRIBES THE UNSEEN PROCESSES CHURNING BELOW OUR FEET THAT CAUSE THEM.

Q: Should we rebuild big cities after disasters?

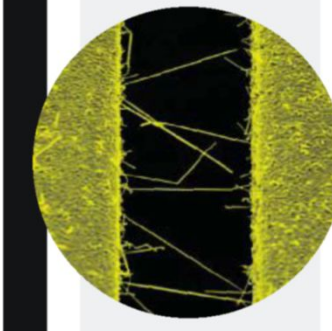
A: We need to learn what we did wrong in the first place and then address truly tough questions: Should we rebuild New Orleans post-Katrina, knowing that another Category 5 hurricane there is inevitable? Should we be living on active earthquake faults, knowing that another magnitude 9 is inevitable, or on coastlines prone to hurricanes or tsunamis? In our world, the answer is unlikely to be no. So, if we are going to live there anyway, then we need to know why we suffered and see what we can do to remediate it.

How is a stealth disaster different from a natural disaster?
Stealth disasters are typically caused by humans but involve the natural systems and processes that support us. They have a much longer time scale for onset—decades, or even centuries. Because of this, we tend to not notice them, or find it convenient to ignore them. With the exception of climate change, they typically don't receive much press coverage. Other examples of stealth disasters are rising sea level, ocean acidification, pollution of our ground and surface waters, erosion and poisoning of soils. Stealth disasters, however, don't have to be inevitable. We could apply what we've learned from natural disasters and then take decisive, timely action, which could do a lot to change the course of stealth disasters.

Will advances in technology ever help us prevent disasters?
We're not likely to change how Earth unleashes its energy on any significant scale, but we can change our preparedness and response to natural processes. Evolving technology can give scientists more and more sophisticated tools for investigating the causes of disasters. With that information, we can better forecast the next disaster and provide timely and universal warnings to the public. — *AS TOLD TO ALYSON SHEPPARD*

TECH WATCH

News Brief
Tin Whiskers



THE PROBLEM

The move to eliminate lead from solder (an alloy used for its low melting point) over the past decade was good for the environment but bad for short circuits. Lead-free tin solder has the strange habit of growing "whiskers"—filaments that extend, causing shorts. Tin whiskers led to a diode failing at a nuclear plant in Connecticut in 2005.

THE SOLUTION

Lockheed Martin developed a printable nanocopper solder paste that isn't subject to whiskering. Copper conducts electricity 10 times better than tin solder does, but its melting point of nearly 2000 F makes it too hot to use on circuit boards. Researchers found that working with copper nanoparticles—less than 10 nanometers across—dropped the melting point to less than 400 F, making a perfect nanocopper solder.
— *ALEX HUTCHINSON*

PHOTOGRAPHS BY JON PATERSON (BOOK), PETER BUSH (TIN WHISKERS)


2014 TOYOTA
TUNDRA
TOW. HAUL. BUILD ANYTHING.
toyota.com/tundra
Prototype shown with options. Production model may vary. ©2013 Toyota Motor Sales, U.S.A., Inc.
TOYOTA
Let's Go Places

ICONS BY **MARTIN LAKSMAN**

The Future of Secure Air Travel

RESEARCHERS ARE DEVELOPING TECH TO MAKE FLYING SAFER WITHOUT STRAINING RESOURCES OR PASSENGERS' PATIENCE. *BY ERIK SCHECHTER*



TECH WATCH



DISTRIBUTED CHEMICAL SENSORS

The U.S. Naval Research Laboratory is developing a sensor that can track trace amounts of chemicals in explosives. The tiny sensor, called Silicon Nanowires in a Vertical Array with a Porous Electrode (SiN-VAPOR), is superior to dogs in terms of analysis: It can describe in detail what it's detecting. Christopher Field, lead researcher on SiN-VAPOR, sees it eventually paired with other technologies such as CCTV cameras and facial-recognition software to create a checkpoint-less airport.



FASTER EXPLOSIVE-TRACE DETECTION

Finding explosive traces is a time-consuming process involving wipe-downs and residue analysis. Michigan State University researchers came up with a faster method that uses a low-power laser. The system fires two pulses at a target, one in resonance with chemical frequencies found in explosives; the other, a control pulse, slightly out of resonance. A reaction in only the noncontrol pulse indicates the presence of explosives. It's efficient and could be used in X-ray machines.



LONG-RANGE IRIS ID

Researchers continue to extend the range of iris-identification scans. Current systems must be 12 inches or closer to a person's face to "enroll" an iris in a database. In 2010 PopMech reported on an experimental eye scanner that works at 16 feet. Now the Carnegie Mellon University CyLab Biometrics Center has built a device that can perform high-quality scans from almost 40 feet in 3 to 6 seconds. Airport security officers could use the device to quickly confirm passenger identities.



GOLD-COATED PILOT GLASSES

It's a federal offense to flash a laser pointer at an aircraft, but that hasn't stopped some miscreants from trying to blind pilots with them. In 2012 alone there were 3482 laser incidents, according to the FAA. University of Central Florida scientist Jayan Thomas has developed eyeglass lenses with gold nanoclusters that block high-intensity light. The glasses would work against all laser wavelengths while allowing colors and eye-safe light to pass through.

PHOTOGRAPH BY ALAMY

ARCHITECTURE

Invisible Skyscraper

Pasadena-based firm GDS Architects' new building in Incheon, South Korea, is guaranteed not to be an eyesore. Last August the South Korean government granted approval for Tower Infinity, a 1476-foot-tall invisible skyscraper. The Infinity will be built near the Incheon International Airport, but Tower Infinity will be located outside of aviation corridors and will have standard aviation-warning lights. While cities such as Dubai and Shanghai are competing for the status of building the biggest skyscrapers, the Infinity seeks to be the most novel. "Instead of symbolizing prominence as another of the world's tallest towers, our solution aims to provide the world's first invisible tower to showcase South Korean innovation," says GDS's principal designer, Charles Wee.
— *WILL DIETRICH-EGENSTEINER*





GLOSSARY

reflectin

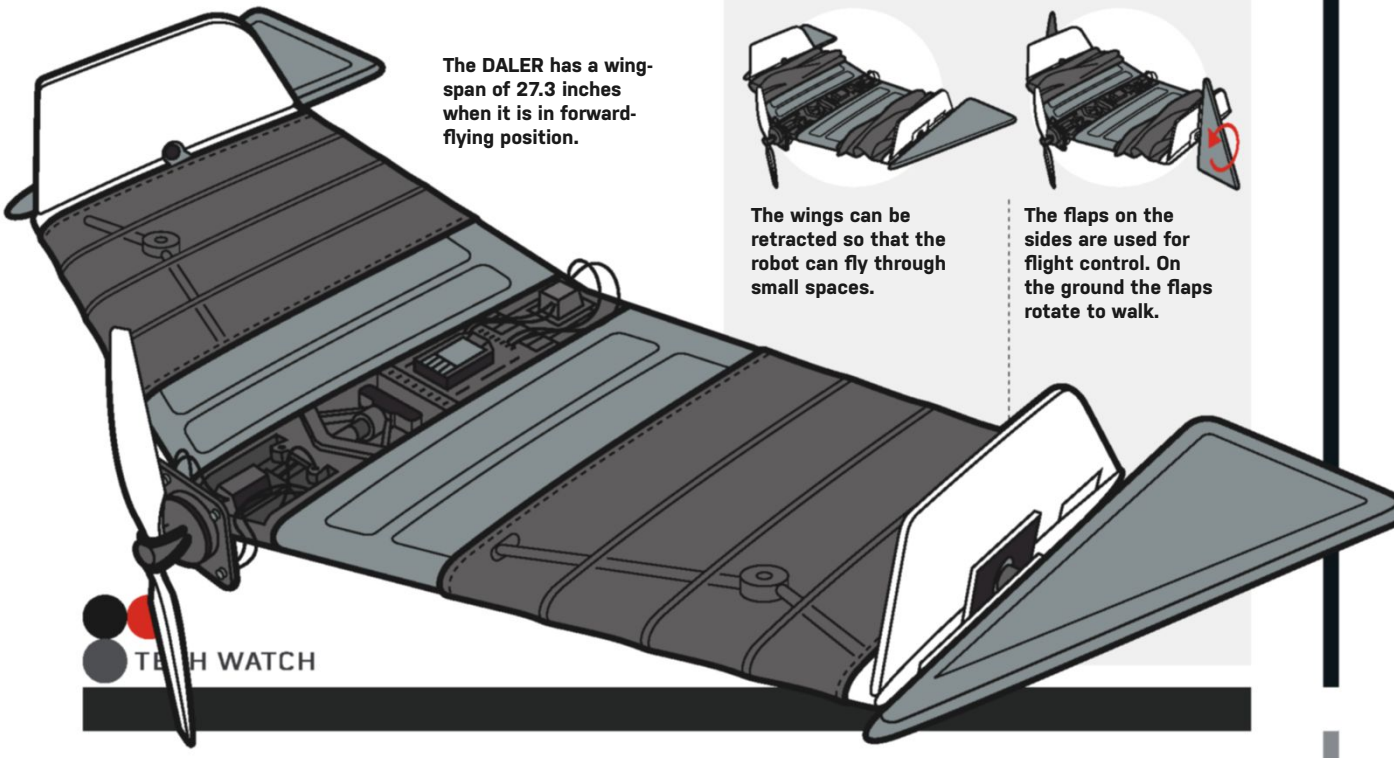
Navy SEALs may soon be able to hide from enemy night-vision goggles by emulating squid. The skin of the common pencil squid (left) is imbued with a protein, reflectin, that changes color and reflects wavelengths of light, enabling it to "disappear." University of California, Irvine, engineers are testing a reflectin-based coating that appears black at wavelengths between 700 and 1200 nanometers. The properties can be adjusted by applying a chemical trigger, so the coating vanishes when viewed in infrared. The goal is to incorporate reflectin in fabrics to make camo that adjusts to various backgrounds and lighting. — *A.H.*

PHOTOGRAPH BY GETTY IMAGES (SQUID)

HEY, NICE WHEGS

The Flying, Crawling Bat Bot

During search-and-rescue missions, it's ideal to have robots that can fly through tight spaces and walk over rough terrain. The DALER (Deployable Air Land Exploration Robot) can do both. Developed by researchers at the Laboratory of Intelligent Systems in Lausanne, Switzerland, the robot can reduce its wingspan and turn the ends of its wings into "whegs"—a cross between wheels and legs—to propel itself across rocky terrain at speeds of a little over half a foot per second. This adaptive morphology avoids the added weight that would be required to incorporate separate air and land locomotion systems. — *A.H.*



The DALER has a wingspan of 27.3 inches when it is in forward-flying position.

The wings can be retracted so that the robot can fly through small spaces.

The flaps on the sides are used for flight control. On the ground the flaps rotate to walk.

TECH WATCH

MEANWHILE, ON THE INTERNET

Blogged Today, Gone Tomorrow

From the Arab Spring to the death of Michael Jackson, the first draft of modern history is recorded on Twitter and other social media platforms. But how long do the messages last? Hany SalahEldeen and Michael Nelson, computer scientists at Old Dominion University in Virginia, have been studying the life span of Internet content to determine how much of this content will be available to historians in 100 years—or even 100 days. — *A.H.*

20%

The amount of content linked to on Twitter that has been saved in public archives within one year of posting.

11%

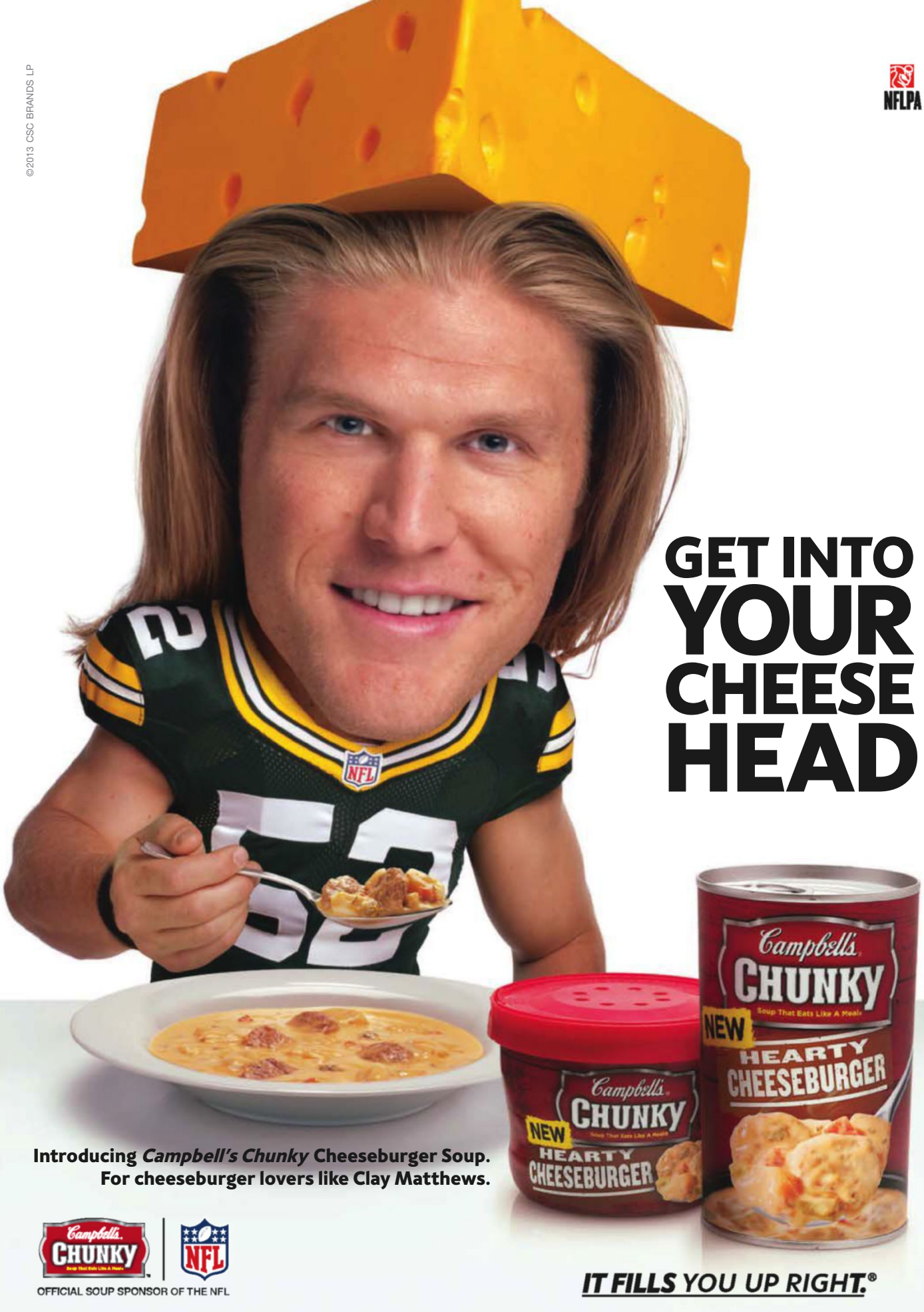
The amount of content linked to on Twitter that has disappeared within one year of posting.

0.02%

The amount of the remaining content disappearing every day after the first year.

©2013 CSC BRANDS LP

NFLPA



Introducing *Campbell's Chunky* Cheeseburger Soup.
For cheeseburger lovers like Clay Matthews.

Campbell's CHUNKY | NFL

OFFICIAL SOUP SPONSOR OF THE NFL

***IT FILLS* YOU UP RIGHT.®**


MATERIAL4X
DURABILITY REDEFINED
MATERIAL4X® is the next generation
of abrasion resistant material
ORIGINAL® 4X
M-PACT® 4X
MECHANIX GLOVES. THE TOOL THAT FITS LIKE A GLOVE.®
MECHANIX WEAR
www.mechanix.com

Upgrade

GEAR
TOOLS
GADGETS

Edited by
JENNINGS BROWN

Nest founder Tony Fadell, the designer behind 18 generations of the elegantly simple iPod and the first three iPhones, created a detector that isn't frustrating or hideous. It's about time.



SMART-HOME TECH

Fighting Fire

Here's a startling fact: About two-thirds of fire deaths in U.S. homes occur in those without working smoke alarms. Sadly, human error is usually to blame. The most common reason a detector doesn't work is because people remove and fail to replace the battery after an annoying false alarm or in reaction to the even more annoying chirping when the battery is low. Some knuckleheads

admit to not installing smoke alarms because they're just plain ugly.

The Nest Protect crushes those excuses. Recently introduced by the same company that put the innovative Nest Learning Thermostat on the market two years ago, the smoke detector ($129) combines impressive functionality and handsome looks. A Siri-like voice ensures that homeowners won't sleep through an alarm, and a halo around the Nest insignia glows yellow or red to alert homeowners to potential danger.

What makes the Nest Protect so smart? In a word, sensors. They detect not just heat, light, sound, smoke, and carbon monoxide but also motion. If there's a false alarm, just wave your arms by the gadget and it stops sounding—no need to remove that 9-volt. The device's Wi-Fi-enabled capabilities allow battery and system updates to be sent to your phone via the Nest app. Units can be networked, so if a fire starts in an unoccupied room, the wirelessly connected system sends alerts through every device.

In fact, the Protect can also work in concert with the Learning Thermostat. For example, if Nest Protect detects a rise in carbon monoxide levels, the thermostat turns off the gas furnace, a common culprit in carbon monoxide leaks. Such interactivity suggests that Nest will continue to add other devices to its evolving ecosystem, moving us closer to the fully automated smart home one device at a time. — *DARREN ORF*

HOW IT WORKS

Cub Cadet 3X Snow Throwers

If there's anything satisfying to be found in snow removal, it's in bringing brute force to bear on the job. Cub Cadet's 3X throwers ($1400 to $1800) incorporate a third stage, an industry first that allows the machines to clear 50 percent faster than two-stage machines. — *ROY BERENDSOHN*



STAGE 1: A pair of collection augers rotate from the outside of the intake chute to its center, gathering snow and breaking it up.

STAGE 3: A discharge impeller throws the snow clear. The stuff flies a long way, given the machine's enormous power, so be sure not to aim the discharge at your neighbor's kids, dogs, or cars.

STAGE 2: More pulverizing power comes from a high-volume, vertical rotor between the two augers.


PEACE CORPS
For dreamers
who do.
Live, learn, and work
with a community overseas.
Be a Volunteer.
peacecorps.gov



STANLEY 100-YEAR CLASSIC VACUUM BOTTLE, $38
Stanley celebrates a century of leakproof, rustproof service with a limited-edition steel bottle in vintage green. Vacuum insulation keeps beverages hot or cold for up to 24 hours, and you can use the lid as an 8-ounce cup to sip joe the way gramps did.

CAMELBAK FORGE BOTTLE, $30
It'll take a lot more than a straw to break this CamelBak. The side button opens the leakproof drinking hole, allowing one-handed use. The Forge also has vacuum insulation (though it only keeps beverages hot for up to 4 hours). A flip-up impact cap makes the bottle easy to clean and hard to break. — *AMANDA GREEN*

UPGRADE



BRUNTON HYDROGEN REACTOR, $150
1 Few things are geekier (read: cooler) than charging your phone with hydrogen. A platinum catalyst in the fuel cell separates negatively charged electrons from positively charged hydrogen ions, creating electricity. So, yes, it's a hydrogen reactor that fits in your pocket. Plus, because the hydrogen cells are solid-state, there's no discharge—other than water vapor, which you can hear being released in little puffs. The charger should be safe as long as you keep it at temperatures below 120 F. It comes with two cores, each one good for six charges. Additional cores cost $20 apiece. — *RACHEL Z. ARNDT*

INNOVATION FACTORY TRUCKER'S FRIEND, $60
2 Originally designed for those who spend most of their lives on the road, this 19-inch multitasker can be used to hammer, chip ice, or break out of a sinking cab. Our trucker friends use it to tighten chains, chop wood, and pry metal, but we know a search-and-rescue team that also relies on the tool. — *JAIME NETZER*

BLUELOUNGE ROLIO, $10
3 Stop plopping your phone on the floor next to the outlet. A slim square that lets you keep your charging cable neatly coiled is nice, but even nicer is if that square does something useful, like support an iPhone-faced wall clock. — *R.Z.A.*

PHOTOGRAPHS BY JON PATERSON

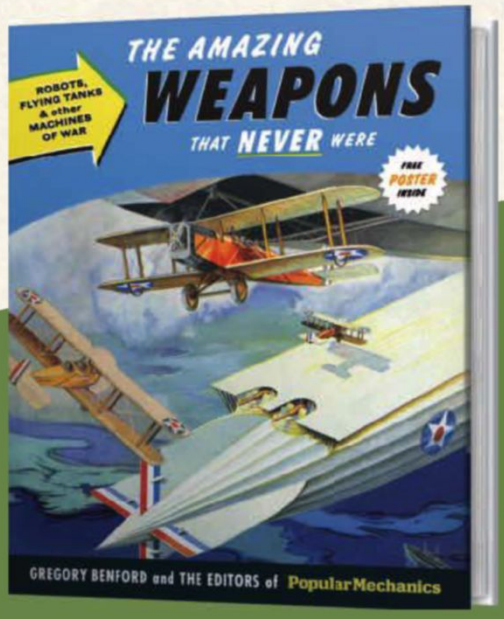
SEE THE FUTURE THROUGH THE EYES OF THE PAST!

THE AMAZING WEAPONS THAT NEVER WERE



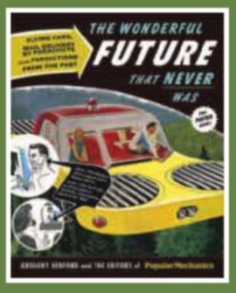
For more than a century, scientific and military experts have imagined a world of weaponry that included death rays, robot spies in outer space, and dirigible mother ships holding dozens of planes. Some predictions were shockingly prescient; others hilariously wrong—and you'll find them all in this new book alongside the stunning original color art.

Edited by Nebula-award winning author Gregory Benford.



978-1-58816-862-7

ALSO AVAILABLE



"ALL THESE FANTASTICALLY FABULOUS FUTURES, AND I GET TO LIVE IN NONE OF THEM—AND NO, HAVING AN iPOD TOUCH DOES NOT MAKE UP FOR IT—BUT AT LEAST I HAVE THIS BOOK, WHICH ALMOST DOES."

—JOHN SCALZI, BESTSELLING AUTHOR OF *OLD MAN'S WAR*

HEARST BOOKS Available in hardcover or as an ebook wherever books are sold.

PHOTOGRAPH BY **ERIC HELGAS**



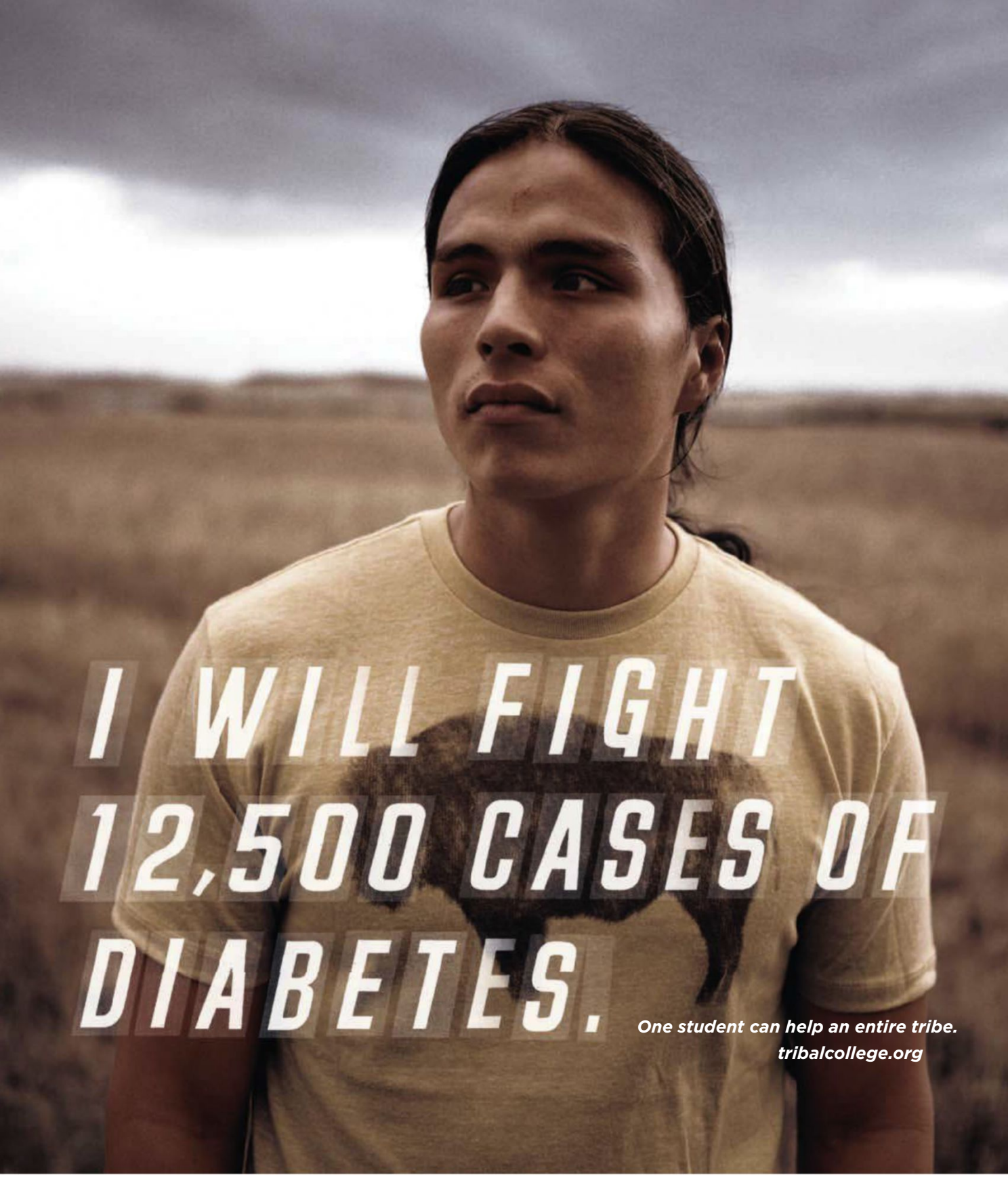
CELESTRON CAVALRY 7x50 BINOCULARS, $250
Besides providing a sharp, bright view, Cavalry throws in an LCD screen that shows the date, time, compass information, elevation, and GPS coordinates. A reticle helps you calculate the size of objects and how far away they are. — *R.Z.A.*

UPGRADE



MARSHALL STANMORE, $400
Marshall's wireless speaker not only looks like a Marshall amp head but booms like one too. Whether the Stanmore is connected via Bluetooth, a headphone cable, or RCA connections, music sounds crisp, clean, and—though the amp doesn't actually go to 11—satisfyingly loud. — *R.Z.A.*

PHOTOGRAPH BY JEFFREY WESTBROOK (BINOCULARS)

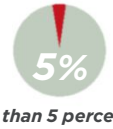


One student can help an entire tribe.
tribalcollege.org

Akisa
Nursing
Oglala Lakota College, SD



Growing up, I was always helping people. I was the kid on the playground breaking up fights. I would sneak money into my mom's purse because she was too proud to take it. I helped take care of my grandmother when she got diabetes and then cancer. Now I'm getting my degree to be a nurse so I can keep helping my community.



Less than 5 percent of American Indians can afford college without assistance.

AMERICAN INDIAN COLLEGE FUND

PHOTOGRAPHS BY **JON PATERSON**

TOOL ROUNDUP

Point And Shoot

Sometimes two hands are not enough, for instance, when it comes to fastening trim or hanging drywall. Tasks such as these require one hand to support the material, another to grip the tool, and a third to position the screw or nail. Don't have three hands? Don't worry—the tools here will do the last part for you. — *DAVID AGRELL*

UPGRADE



SENCO FINISHPRO 23SXP MICRO PINNER ($159)

1 This pneumatic nail gun drives headless nails so narrow—the 23-gauge wire measures about 0.025 inches in diameter—that they're practically invisible, and they won't split the wood. That means less reaching for putty when installing stain-grade moldings. Senco's upgraded motor handles wood as hard as oak, and the magazine carries up to 100 fasteners ranging in size from ½ inch to 1⅜ inches.

RYOBI P320 18-GAUGE CORDLESS BRAD NAILER ($129 FOR TOOL ONLY)

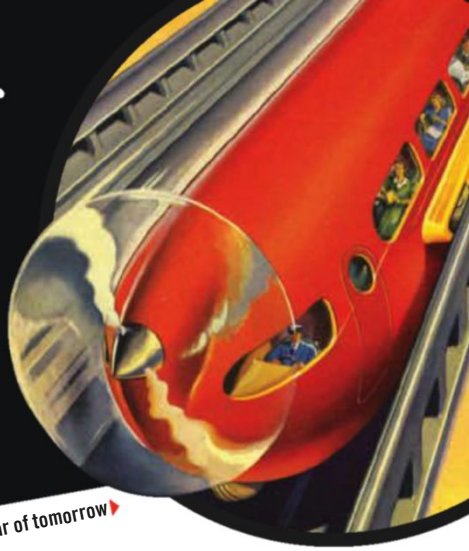
2 Not just for those who don't own a compressor, cordless nailers offer grab-and-go efficiency for quick repair jobs. The P320's AirStrike system compresses ambient air within the tool to fire the nail—no gas cartridge or hose needed. The lack of an air hose makes this tool easier to use up a ladder. A single battery charge will fire up to 700 18-gauge nails.

MAKITA BFR750 CORDLESS AUTOFEED SCREWDRIVER ($239 FOR TOOL ONLY)

3 Sure, it looks like something out of Gears of War, but this is no toy. The 18-volt battery-powered drill automatically feeds from a strand of screws that coils out of a bucket, driving the fasteners at 4000 rpm. In other words, you can fasten drywall, subflooring, or decking in record time. Bonus: An optional extension handle saves you from ever having to bend over.

Popular Mechanics TAKES YOU...

BACK TO THE FUTURE

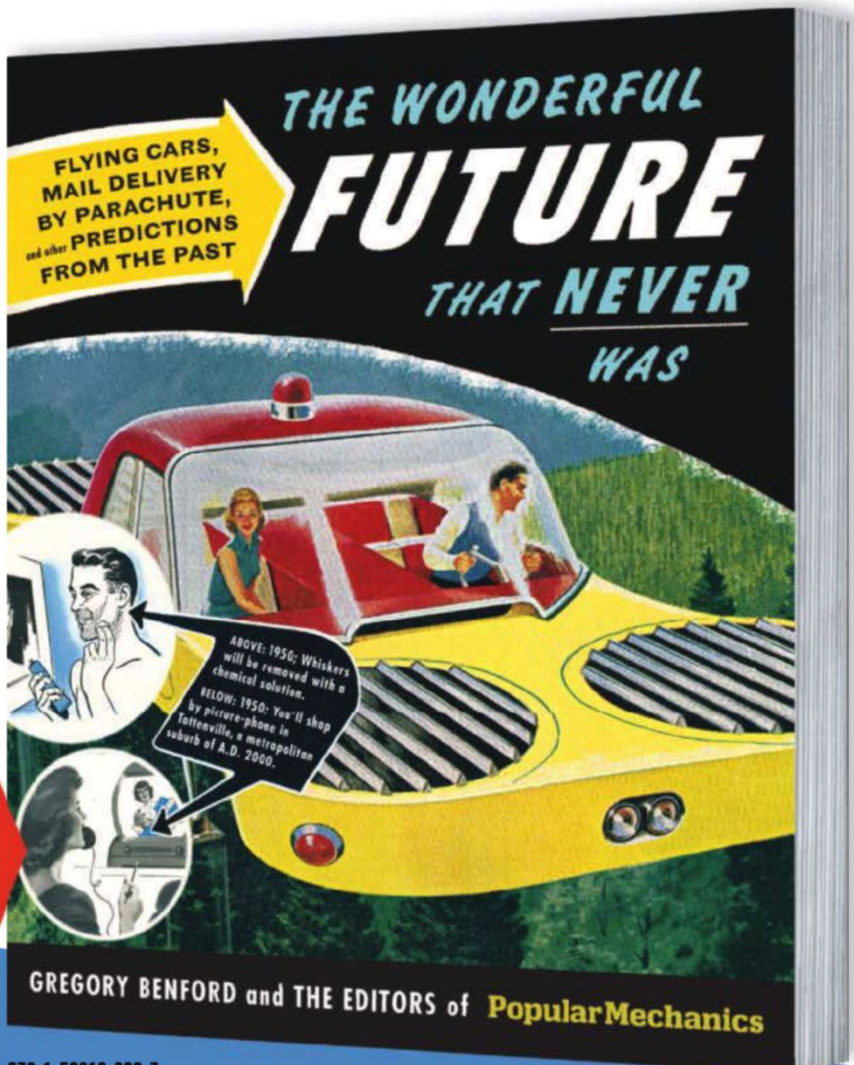


1940: The torpedo-like rail car of tomorrow

Over the decades, scientists have peered into their crystal balls, envisioned the world to come…and shared their predictions with readers of *Popular Mechanics*.

What did they see? Flying ambulances. Space suits made from paper. Utopian cities with elevated sidewalks and sunken streets. Even the cure for the common cold.

In our brand new book—a collection of these speculations with original text by Nebula winner and NASA advisor Gregory Benford—the bizarre, wildly imaginative, and (occasionally) eerily accurate *Wonderful Future That Never Was* comes to life.



978-1-58816-862-7

NOW IN PAPERBACK



$17.95 (CAN $21.95)

AVAILABLE WHEREVER BOOKS ARE SOLD.

1950: Clean your waterproof home with a hose

HEARST BOOKS

PHOTOGRAPH BY **KYLE JOHNSON**

HARDWARE STORE WE LOVE

HARDWICK'S
Seattle

IN BUSINESS SINCE 1932



John Hardwick is the fourth generation of his family to work at Hardwick's.

During his first day on the sales floor in 2005, John Hardwick helped out a boat builder who came in looking for a caulking iron and a marlin spike. That's an odd combo, but Hardwick—the 33-year-old great-grandson of Charles Dean Hardwick, who founded the store in 1932—just shrugged and gathered the tools. "I do a lot of shrugging," John says. "Every day is an education here." Given Hardwick's vaunted inventory, almost no request for goods goes unfulfilled. The family takes great pride in stocking the world's best tools for the city's discerning craftsmen. A walk through the cluttered aisles reveals, for example, Japanese pruning shears, Swedish broadaxes, Italian riffler rasps, and Pakistani scissors. Hardwick's bills itself as a swap shop, too, which adds yet another layer of intrigue. Case in point: Sitting beneath the vintage gear, tools, and paintings hanging from the ceiling and on the walls is a hulking, hand-cranked railroad-tie drill. John concedes that it's not likely to sell anytime soon, if at all, but says that the device draws urban explorers who come in search of antique treasures, as well as durable, well-designed new tools. "The reason we're still around," John says, "is the people who appreciate high-quality stuff, the stuff you're going to pass down to your kids." — *CHRIS RAYMOND*

What's your favorite hardware store? Email us at popularmechanics@hearst.com.

A Better Bed = Better Sleep



101 Night No-Risk Trial
Each Reverie® Dream Sleep System™ includes a 101 Night No-Risk Trial so you can try your new bed in your own home.
No return fees. No restocking fees. No fine print. No hassles. 100% refund.

Everything comes together in each Reverie® Dream Sleep System™ to provide you with an ideal environment for rest, relaxation and rejuvenation.

The Bed Designed for You

Every aspect of each Reverie® Dream Sleep System™ is designed to provide you with the perfect place for sleeping, reading, watching TV, talking with your partner or even working on your laptop or iPad.

Support You Can Customize

Reverie® uses patented support technology so you can customize the firmness level to your exact preference on both sides of the bed. Plus you can change your firmness level in just minutes if your preferences or needs change.



DreamCells™ come in four firmness levels and are custom configured to meet you and your partner's support preferences.

Adjustable Foundation for Sleeping and Relaxation

The adjustable foundation allows you to raise or lower each side of the bed independently so you can relax and sleep in comfort. There's an Anti-Snore setting for those who snore or have acid reflux and the Zero-Gravity setting is particularly soothing for those with back pain. You'll never want to go back to a flat bed.

Natural Materials for a Healthy Sleep Environment

Reverie® uses natural breathable materials for healthy, comfortable sleep. Our sustainable plant-based materials are naturally anti-bacterial, anti-microbial and dust mite resistant. And they look great and will last for years and years.

Built-in Full Body Massage

Each Reverie® Dream Sleep System™ includes a gentle, full body massage for total relaxation and comfort, helping you fall asleep faster. You'll look forward to going to bed each night.

Free Brochure and DVD Info Kit

To learn more about how this revolutionary new bed can improve your life, please request your free information kit.

Call 1-800-685-3445

www.reverie.com

Reverie®

Sleep well tonight. Live better tomorrow.™

Dept. 1039

©2013 Reverie. All rights reserved. 30200 Telegraph Road, Bingham Farms, Michigan 48025

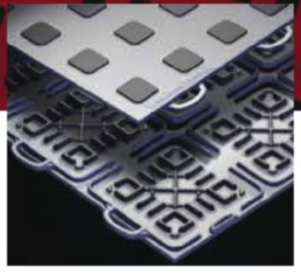
TechFloor™

The Easy to Install Floor Tile

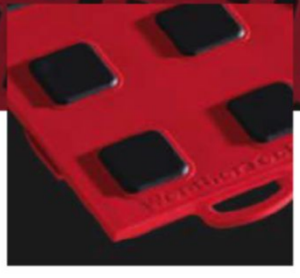
STARTING AT
$2.99
PER SQ. FT

Snaps Together!

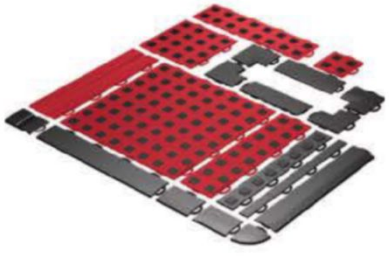
Patent Pending
TwoShot™ Process



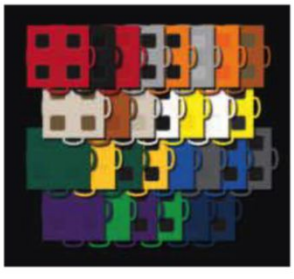
The Rubber Goes Through



Non-Slip TractionSquares™



Tile System Components



Many Colors Available

GREAT FOR
Garage · Workshop · Basement · Laundry Room
Kid's Play Room · Workout Room · Mud Room

AVAILABLE STYLES



Premium with TractionSquares™



Solid with Raised Squares



Smooth Surface



Premium Flow-Thru with TractionSquares™



Solid Flow-Thru with Raised Squares



Smooth Surface Flow-Thru

www.TechFloor.com 800-441-6287

WeatherTech®

Made in USA

©2014 by MacNeil IP LLC

Auto INTEL



AN INTERNAL RFID TAG MEANS THIS BOLT KNOWS MORE ABOUT YOUR ENGINE THAN YOU DO.

TEST DRIVES
TOP TECH
HOT RIDES

Edited by
ANDREW DEL-COLLE

A Smarter Bolt

GM'S DATA BOLTS ARE THE KEY TO A NEW HIGH-TECH ASSEMBLY LINE. *BY MATTHEW DE PAULA*

Engines are complicated, and a lot can potentially go wrong during assembly—malfunctioning machines, faulty parts, and, of course, human error. But at its factory in Tonawanda, N.Y., General Motors has taken a high-tech approach to preventing and catching these problems. And it's all thanks to a humble little bolt.

The 75-year-old factory recently underwent a $400 million upgrade to start building a new line of Gen 5 six- and eight-cylinder engines. It's the first of the automaker's manufacturing facilities to implement a new "track-and-trace" system by using radio-frequency-identification (RFID) technology. GM has used RFID tags

REVIEWS



Cadillac CTS



Nissan Rogue



BMW i3

+

Kia Soul
Toyota Corolla
BRP Can-Am Spyder

in its factories for more than 10 years to identify assembled engines, but now the company is attaching them directly to the cylinder heads and engine blocks using what the company calls a data bolt. It's shaped like a regular bolt and is threaded on one end, but the head is hollow. Inside, secured with epoxy, are a memory chip (or RFID tag) and a coiled metal filament, which acts like an antenna.

As its name implies, the data bolt stores information—2 kilobytes' worth, to be exact. That's a very small amount of data by modern standards (only a fraction of an MP3 audio file's 3 to 5 megabytes). But it's enough to record every single manufacturing process the engine block or cylinder head undergoes. And that is the key to the whole track-and-trace system: All of the data from each bolt gets uploaded to servers housed at the factory.



When the cylinder heads and engine blocks are joined at General Motors' engine plant in Tonawanda, N.Y., the engines are mounted onto pallets that have their own RFID tags with which the cylinder head and engine block serial numbers are merged. By then, the assembly information recorded by the RFID tag in the data bolts has already been backed up to a central server for easy retrieval.

DOWN THE LINE

In total there are about 50 different points throughout the production line where data gets transferred to and from the bolts. Just about every automated machine on the line has an RFID scanner to read the data bolt before it performs its task, and another RFID writer that logs new information onto the bolt once the machine has done its job. If any of the machines on the floor do not complete their duties to perfection, the next machine in line can tell and will shunt any out-of-spec engine block or cylinder head off the line to be inspected by a worker.

Likewise, if a block or head gets pulled to undergo a gauge test for appropriate tolerances but somehow gets left offline at the end of a shift, it can't be put back into the wrong place in the production process, which sometimes used to happen. "That has saved us a couple of times already," Peter Laskiewicz, a manufacturing process engineer for GM, says, "especially during launch, when you've got a lot of parts everywhere and are trying to understand where they go." Skipping a single process could crash one of the 30 new digitally operated milling machines that use computerized coordinates to hone surfaces and drill and top holes in the engine blocks and cylinder heads. Such mistakes can cost the company about $1 million apiece, Laskiewicz says.

Once the cylinder heads are fully milled, they're attached to the block using a machine that screws down all 20 bolts at the same time. Here again, the RFID tracking is invaluable, allowing workers to tell whether each bolt was successfully installed. This is also critical, because some bolts require such a precise tolerance that they can only be torqued and retorqued a certain number of times. In the past if a bolt attaching a bearing cap to an engine block got flagged for improper tolerance, for example, a worker could retry and sometimes get it to pass muster, even if it wasn't fully within spec. And that was an oil leak just waiting to happen.

Although quality control during the manufacturing process is the main goal of the new data-bolt RFID system, it is also proving to be a huge help in post-production troubleshooting. If a supplier notifies the factory of a bad batch of parts, it's easy to zero in on the exact engines on which they were installed using the database of information saved from the bolts. General Motors plans to implement the track-and-trace RFID system in other factories but hasn't said when it will do so. Marc Brazeau is a director with AlixPartners, a global consulting firm with expertise in manufacturing processes. Brazeau says that what GM is doing is exciting and has the potential to spread to industries such as appliance manufacturing: "Four or five years from now you're going to see a lot of different types of applications."

nextissue™

100+ MAGAZINES | ALL-YOU-CAN-READ ACCESS | ONE LOW PRICE

Try it FREE for 30 days



START YOUR FREE TRIAL TODAY AT **NEXTISSUE.COM**





2014 Cadillac CTS

AUTO INTEL

With a 4.2-inch increase in length, the new CTS is in the same dimensional class as the Audi A6, BMW 5 Series, and Mercedes-Benz E-Class. But in building the CTS, Cadillac used many of the same parts from its agile ATS compact sedan. The result is a curb weight hundreds of pounds less than the previous, smaller CTS. That translates into handling that has the potential to dust the class benchmarks on a tight and twisty road. Best of all, you don't need to be in the most expensive model to have fun. The base 2.0-liter turbocharged four-cylinder models offer the same driving zest as the 3.6-liter V-6 but with less pain at the pump and 100 pounds less heft. Then there's the 420-hp, twin-turbocharged V-6 in the Vsport, which hits 60 mph in just 4.4 seconds and won't stop pulling until the speedometer sees 172 mph. Up front, Cadillac continues to impress with comfortable seats and beautiful leather and wood appointments. The rear seats are a little cramped for the segment, but there's still plenty of room for a six-footer to handle a road trip. And when you're whipping up a mountain pass, neither you nor your rear-seat passengers will miss the space. — *BEN STEWART*

PRICE: $46,025 AVAILABLE: NOW MPG (CITY/HWY): 19–20/28–30 (I-4), 18/26–29 (V-6), 16/24 (TURBO V-6)

2014 Kia Soul

What's new: At first glance it's hard to tell this Soul from the 2013 model, but the sheet metal is totally different, as are the underlying structure and the freshened interior. A retuned suspension and revised powertrains round out the upgrades.
What's unusual: Both engines get new camshafts, and the 2.0-liter joins the direct-injection club. The changes are meant to improve low-end torque, but you won't see that in the peak figures—the 2.0 liter's power is unchanged (with 3 lb-ft more torque), and output actually drops 8 hp and 5 lb-ft in the base engine. At least the 2.0-liter gains 3 mpg on the highway.
What's improved: The body shell is stiffer by 28.7 percent, and the suspension is tuned for more compliance. That means a smoother ride, increased stability—particularly on nasty surfaces—and a significant uptick in comfort. Substantially reduced interior noise also contributes to a more pleasant cabin.
What's good: The Soul has dominated the market for funky-looking affordable transportation, and this newest version tidies up most of the ragged edges of the old car without losing any of its quirky charm. — *TONY SWAN*

PRICE: $15,495 AVAILABLE: NOW MPG (CITY/HWY): 24/30 (1.6-LITER), 23–24/31 (2.0-LITER)





Were you there? Providers in the New York City area, and across the country, monitor and treat conditions related to the September 11th terrorist attacks – like asthma, heartburn, certain cancers, depression, and PTSD. These providers treat responders and volunteers who participated in rescue, recovery, or clean-up on or after 9/11, as well as those in the WTC dust cloud or who lived, worked, or went to school or daycare in lower Manhattan south of Houston or into parts of Brooklyn.

Learn More.

Call 1-888-982-4748 or visit www.cdc.gov/wtc

World Trade Center | Pentagon | Shanksville, PA

9.11
WTC Health Program

Image is a model portraying an actual member of the World Trade Center Health Program.

2014 Nissan Rogue

Compact crossovers are a hot segment, and the competition is just as fiery. For this reason, Nissan set out to make the subtle Rogue more of a standout among its peers for 2014. The sheet metal gets a theatrical overhaul with more curves and creases, a distinctive new V in the grille, and stylized daytime-running and brake lights. Jump behind the wheel and you'll immediately be impressed by the upgraded interior, which is rich with soft-touch materials and piano-black detailing. In the AWD SL trim we drove, the Rogue glides effortlessly through sweeping curves, but the 170-hp 2.5-liter engine struggles to provide acceleration on inclines or while passing, hampered by a CVT that makes it feel as though the car's wheels are driving through mud. But racing isn't what this car is for, and, more appropriately, the Rogue takes the title for best mpg in its class. Add in options such as a touchscreen nav system that can link to your smartphone via a special app and standard new tech like active engine braking, which adjusts the CVT for smoother coasting, and the Rogue delivers on every front Nissan intended. All of these improvements do come with a base-price increase, but considering what you get, the bang is certainly worth the few thousand extra bucks. — *ANDREW DEL-COLLE*



PRICE: $23,350–$30,280
AVAILABLE: NOW
MPG (CITY/HWY): 26/33 (FWD), 25/32 (AWD)

AUTO INTEL

2014 Toyota Corolla



***That's* a Corolla?** Yes. Yes, it is. No longer a complete toaster, this perennial mass-market hit now has a radical (for Toyota) new style, more connectivity, and more personalization.

So, everything is updated? Not exactly. Most models, including the Sport, get the current 132-hp 1.8-liter four-cylinder paired to either a six-speed manual or a CVT (a four-speed auto is available for the base L model). The LE Eco trim receives a new variable-valve-timing version of the engine, which boosts efficiency and adds 8 hp.

How's it for space? A 4-inch stretch in length yields a 5-inch improvement in rear-seat room, making the Corolla a segment leader. Trunk room improves from 12.3 to 13.0 cubic feet.

Is it fun to drive? It's certainly livelier than its predecessor, but the Corolla still falls short of the pack on back roads. — *B.S.*

PRICE: $17,610
AVAILABLE: NOW
MPG (CITY/HWY): 27–30/36–42

Popular Mechanics

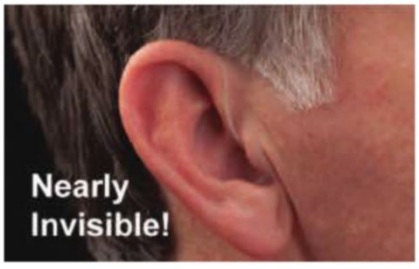
IN THE KNOW

THE ONE STOP SHOP FOR THOSE WHO **KNOW IT. ALL.**

TINY NEW AFFORDABLE HEARING AID

The MDHearingAid® AIR is doctor designed and delivers the same hearing experience as devices costing thousands of dollars for 90% less. It is an FDA registered state of the art digital hearing aid that provides crystal clear, natural sound – in a crowd, on the phone, in the wind –without "whistling" or annoying background noise. Call today for a 45 day risk-free trial offer with a 100% money back guarantee and get FREE batteries for a full year.

Call 1.800.873.0541 with promotional code TR17 or visit www.MDHearingAid.com for more information.





ACTION HEROES WANTED

The TAC-7 was made for our real action heroes: the firefighter, the police officer, and the ambulance driver. It is made from super tough stainless steel with luminous hands. The precision movement oscillates at 32,768 Hz for astounding accuracy. And since we never pay our heroes anywhere close to enough, the watch that was originally $299 is now only $59 + S&H.

Call 1.888.306.7188 with promotional code TAC159-01 or visit www.stauer.com for more information.

YOU KNOW SOMEONE WHO DESERVES IT.

Bring yours home today for 74% OFF. Our Stauer Spring Emerald Necklace features 15 carats of genuine emerald beads, hand-wired together with delicate gold-finished links. Today you have the chance to own this stunning collection of stones (available online for $299) for ONLY $79! Your satisfaction is guaranteed.

Call 1.800.721.0373 with promotional code SEN157-02 or visit www.stauer.com for more information.



LOOK BETTER. SEE BETTER.

Imagine being able to view the world as crisply and clearly as a football game on an HDTV screen. Advances in lenses make superior vision with glasses possible using specialized treatments and HD technology. Lightweight lenses that are made to fit your exact prescription while eliminating glare and repelling water and fingerprints will allow you to see—and look—better than ever.

Visit www.thevisioncouncil.org for more information.

THE VISION COUNCIL

PM FLEET

CARS WE LIVE WITH

2014 CHEVY CRUZE DIESEL
2014 MAZDA6
2014 SUBARU FORESTER

•

INTRODUCTIONS



A 2014 CHEVY CRUZE DIESEL

THE LOWDOWN

• We're unabashed diesel lovers around here, and considering the Cruze's impressive power and incredible fuel efficiency, it's no wonder why.

SPECS

BASE PRICE/AS TESTED ▷ **$25,695/$26,355**

POWERTRAIN ▷ **Turbocharged 2.0-liter diesel I-4, 151 hp, 280 lb-ft; six-speed automatic; FWD**

EPA FUEL ECONOMY (CITY/HWY) ▷ **27/46 mpg**

B 2014 MAZDA6

THE LOWDOWN

• With European swagger, smart engineering, and great handling, our Auto Excellence pick for car of the year is already a staff favorite.

SPECS

BASE PRICE/AS TESTED ▷ **$25,490/$26,220**

POWERTRAIN ▷ **2.5-liter I-4, 184 hp, 185 lb-ft; six-speed automatic; FWD**

EPA FUEL ECONOMY (CITY/HWY) ▷ **26/38 mpg**

C 2014 SUBARU FORESTER

THE LOWDOWN

• From the smooth ride to the shift-free CVT transmission, the all-wheel-drive Forester is ready to take us anywhere in comfort.

SPECS

BASE PRICE/AS TESTED▷ **$25,495/$26,522**

POWERTRAIN ▷ **2.5-liter H-4, 170 hp, 174 lb-ft; CVT; AWD**

EPA FUEL ECONOMY (CITY/HWY) ▷ **24/32 mpg**

2014 BMW i3

The i3 marks a radical change in BMW's focus, and it's not because it's the company's first true EV. It's because the maker of "the ultimate driving machine" has made a car designed primarily for city commuters. Even stranger is the associated smartphone app. Plug the car into a charging station (the i3 takes roughly 3 hours to fully charge on 220, by the way), and the BMW i Remote App shows all the possible routes to your next destination by foot, bike, or public transit. This is partly due to the EV's limited range, which is about 80 miles



WHEELHOUSE

AUTO ODDS & ENDS

CAR QUIZ

Biokinetic Synchronicity is

- **A** A class at MIT
- **B** A rare phenomenon in nature
- **C** A car-design theme
- **D** A pharmaceutical startup

1 IN 5

drivers would gladly give up the wheel if fully autonomous cars were available, according to a recent survey by CarInsurance.com. This number bumped up to more than one in three with the prospect of drastically reduced insurance rates.



"There were a lot of MP3 players before the iPod. The i3 is like that

(there's an optional gas-powered two-cylinder 650-cc generator that doubles the range). But it's also because the i3 reflects a new way of thinking about transportation for BMW, which is why the interior is designed to feel like a living room—open, airy, and relaxing. That's not to say the i3 is boring, by any means. Using carbon-fiber construction in a car at this price is revolutionary, and one reason we gave the i3 a Breakthrough Award this year. And as you'd expect from BMW, it's also a hoot to drive. Forty grand is a steep price for a car with the functional limitations of an EV, but the i3 just feels special. Traditional gearheads will see it as heresy, but the i3 is proof that BMW's famous tagline means different things to different people.

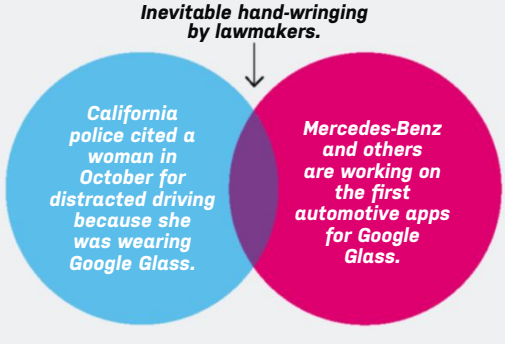
— JENNINGS BROWN

PRICE: $42,275
AVAILABLE: SPRING
MPGE (CITY/HWY, EST.): 125/110



AUTO INTEL

PHOTOGRAPHS BY EMILY ELKINS (SUBARU); NATALIE NEUSCH (MAZDA); SARAH SHATZ (CHEVY)



Answer: C. *Nissan's newest design language, as seen in the 2014 Rogue, and the reigning title holder for ridiculous styling lingo. For now.*

for EVs." Jacob Harb, head of EV operations and strategy, BMW North America



TEST DRIVES

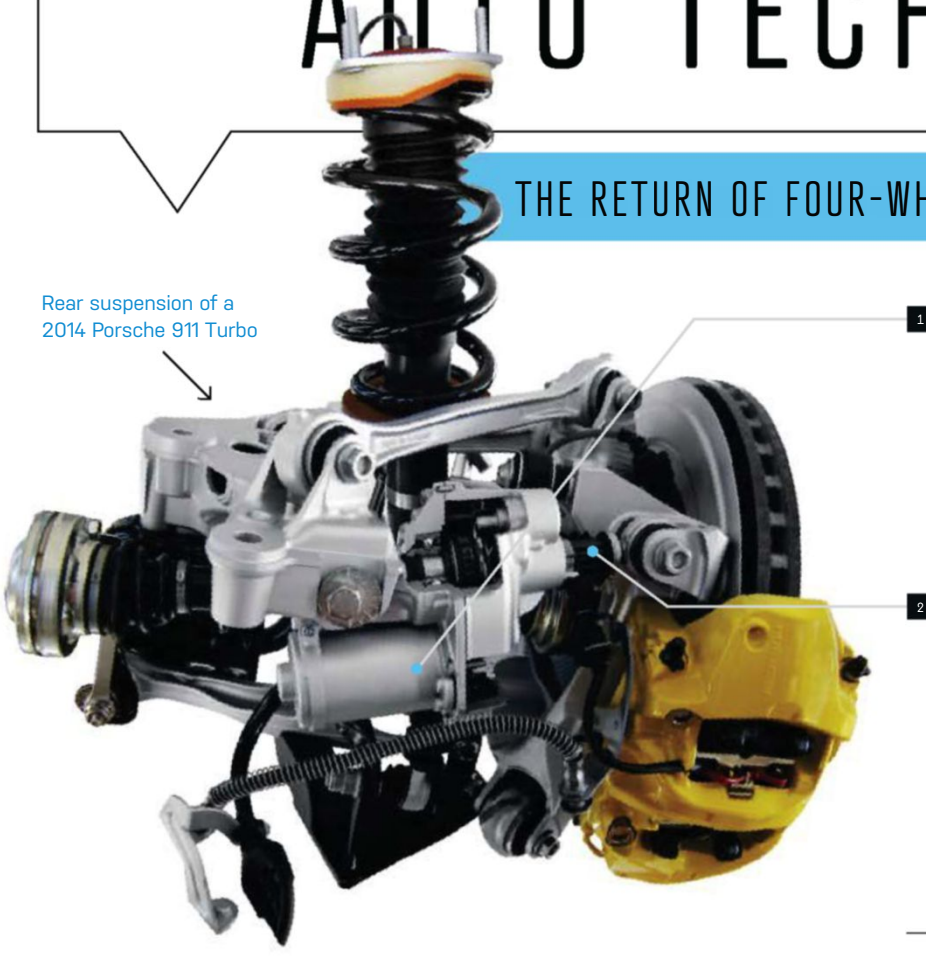
2014 BRP Can-Am Spyder

When BRP's Can-Am road-vehicle division launched its radical three-wheeled Spyder in 2007, there was nothing else like it on the market. Seven years later, that's still true. The Spyder is a favorite among tourers looking for more stability and comfort than that of traditional two-wheeled bikes but who still want the open-air thrills of a motorcycle. This year the RT model debuts atop the lineup with an all-new 1330-cc Rotax three-cylinder paired to a six-speed manual or six-speed semiautomatic transmission. With more torque, the new engine's power delivery is 007-smooth. And overdrive gears in both transmissions means the RT revs less at speed—3600 rpm at 70 mph instead of 5000 rpm—so highway cruising is much quieter. Bend the Spyder RT into a corner and it feels more stable and a bit sharper than the last one we rode. That's because BRP revised the front-suspension design on all models last year, giving them shorter control arms, firmer bushings, a stiffer steering column with larger U-joints, and larger, 15-inch wheels. The suspension tune, however, is soft, so this is one comfy cruiser. And as before, there's ABS, traction control, and stability control to act as a safety net. The Spyder RT's combination of tech and comfort should keep the three-wheeler crowd smiling on every road trip. — B.S.

PRICE: $22,999 AVAILABLE: NOW
MPG (HWY, EST.): 33

AUTO TECH

THE RETURN OF FOUR-WHEEL STEERING



Rear suspension of a 2014 Porsche 911 Turbo

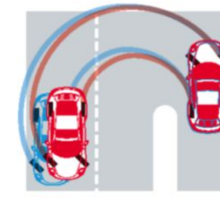
1 Independent ***electric motors*** replace the convoluted steering gearbox in old four-wheel-steer systems. Each computer-controlled motor drives a separate toe link in and out via a belt-driven gear.

2 The ***toe link*** nudges each rear tire to the right or left. Only a few inches of movement is needed: The maximum change at the rear is 2.8 degrees when moving in the opposite direction to the front wheels, and 1.5 degrees in the same direction.

AUTO INTEL

During the late 1980s Honda lead a wave of Japanese manufacturers that introduced four-wheel steering in some sports cars. Why steer all four wheels? At lower speeds, turning the rear wheels in the opposite direction to the front wheels results in a smaller turning radius and faster cornering responses. At high speeds, turning all four wheels in concert improves high-speed stability. The trend was short-lived, though, owing to the complicated mechanical systems and the sometimes scary handling. But with modern electronics, four-wheel steer is back. According to Porsche engineer Andreas Preuninger, the latest systems are so fast, you can't tell when they're working. Currently, Porsche uses four-wheel steering on the 911 GT3, 911 Turbo, and 918 Spyder. Acura offers a similar system on the RLX. — *MICHAEL AUSTIN*

TURNING RADIUS



At low speeds, four-wheel steer helps the ***911 Turbo*** U-turn in 34.8 ft, 1.6 tighter than the ***911 Carrera 4***.

GLOSSARY

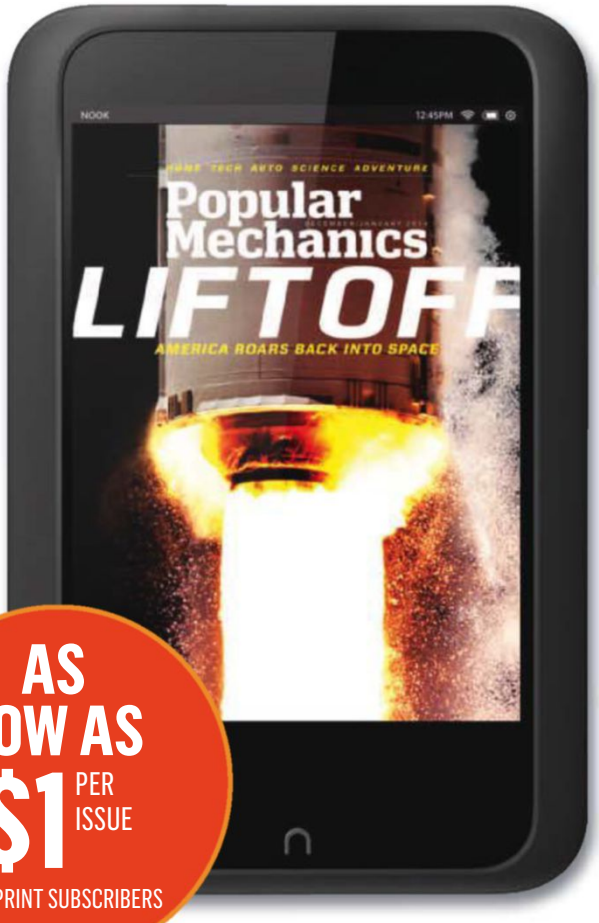
skeuomorph — **Any physical or digital element that once had practical applications but is maintained merely for familiarity or ornamentation. In vehicles with digital dashboards, round gauges are skeuomorphs. On an EV, a grille is another example, as there is no need for airflow to the radiator.**

ILLUSTRATION BY MARTIN LAKSMAN

PROMOTION

50% OFF FOR *POPULAR MECHANICS* SUBSCRIBERS ONLY

With the NOOK app, you can read anytime, anywhere, and **on any device.**



AS LOW AS $1 PER ISSUE
FOR PRINT SUBSCRIBERS

By using the NOOK app, you can get *Popular Mechanics* on your phone and tablet—including your NOOK, iPad,® iPhone,® Android™ devices, and Windows 8 tablets.

Best of all, you can preview a *Popular Mechanics* digital subscription **FREE for 14 days,** and **continue at 50% off—as low as $1 per issue!**

Try it now, and enjoy bonus features and exclusive content; easy access on any device with the NOOK app; and the joy of reading your favorite magazine on the go!

nook.com/popularmechanics

nook newsstand™
by Barnes & Noble

PM FLEET

CARS WE LIVE WITH

2013 RAM 1500 SLT CREW CAB

•

PARTING TAKE

2013 RAM 1500 SLT CREW CAB

WE LOVE TRUCKS for a lot of reasons, but the Ram 1500 caught us by surprise with its comfort. Sure, it did great doing trucklike things—towing a boat, taking a trip to the scrap yard, moving mattresses—but the Ram drew the most raves for its road-trip prowess. The 26-gallon fuel tank helped us cruise as far as 450 miles between fill-ups, and the eight-speed automatic transmission kept the 5.7-liter V-8's thirst in check. We especially liked the cushy air suspension and the way it automatically lowers the truck for easy access, but it was also the source of our main complaint. Before the truck could rise to its normal driving level, the low ride height caused the tires to rub on the wheel wells during turns. Still, after almost 7000 trouble-free miles, we're sure going to miss the big Ram. — *M.A.*

DRIVERS NOTEBOOK

- I've seen apartments smaller than this back seat; it's huge.
- The locks on the Ram Box bed storage compartments are loud enough to wake the neighbors.

END DATA

BASE PRICE/AS TESTED ▷ **$35,175/$44,125**

MILES DRIVEN ▷ **6772**

MAINTENANCE ▷ **None**

PM FUEL ECONOMY ▷ **Average: 18.2 mpg**
Best: 20.3 mpg
Worst: 15.7 mpg



CARCHAEOLOGY

AUTOMOTIVE ARTIFACTS

1952

General Motors Autronic Eye



OLDSMOBILE MIGHT BE history now, but back in 1952 the company *made* history along with Cadillac when the brands offered GM's Autronic Eye, the first automatic headlight-dimming system. When the phototube mounted on the dashboard detected approaching headlights, it would automatically switch the car's beams to low until the other lane was clear. Despite reportedly being overly sensitive and unreliable, the Autronic Eye evolved, and versions spread to other GM brands and continued in Cadillacs until the 1988 model year. The Eye also made its way into GM's fantastic fleet of stylized Futurliners. Part of the General's rolling technology showcase in the early 1950s called the Parade of Progress, these 33-foot behemoths moved from town to town converting into stages and exhibition areas, thanks to 16-foot foldable side panels, a retractable lighting tower, and a public address system. Ironically for vehicles showing off revolutionary technologies, the Futurliners had terrible brakes and had to stay 300 feet behind other vehicles. Of the 12 built, two remain unaccounted for. Know what that means? There's still hope for making the ultimate taco truck. Who's in? — *A.D.C.*

PHOTOGRAPHS BY PETER BAKER (FUTURLINER)

Introducing

MediaFlair™

by ESCORT

Personal Media On-The-Go!

Listen with friends

Watch movies on road trips

Share presentations and documents



MediaFlair™ is an exciting new way to listen, watch and share your media. Using the power and simplicity of WiFi, MediaFlair streams your personal content to your favorite smartphone or tablet using our free and easy to use app.

Simply load your music, movies, photos and documents onto the included SD card and take it with you. It's perfect for road trips with the kids, business travel and tailgating with friends and family.

It's small, lightweight and provides up to 4 hours of use on a single charge. Plus, multiple people can watch or listen to any file that's on your SD card at the same time.





MediaFlair $99.95

with 8GB SD Card, 12v Adapter, and USB Cable

Available on the App Store | Google play | Available at amazon

800-852-6258 EscortInc.com/MediaFlair Facebook.com/DriveSmarter

Department PMECH ©2013 ESCORT Inc.

NATURE
CLEANS OUR AIR



Did you know that trees absorb

1/5

of carbon emissions?

Sixty years ago, The Nature Conservancy's first act was conserving a forest in New York. Today, we help people all over the world to protect the life-giving services their forests provide.

Help nature to breathe easier.
Learn how at **nature.org**.

The Nature Conservancy
Protecting nature. Preserving life.

TECH CORNER
by WeatherTech®

BumpStep™

HITCH MOUNTED BUMPER PROTECTION



WeatherTech® BumpStep™ is molded out of a proprietary resin in the USA and fits any vehicle with a standard 2" receiver hitch.

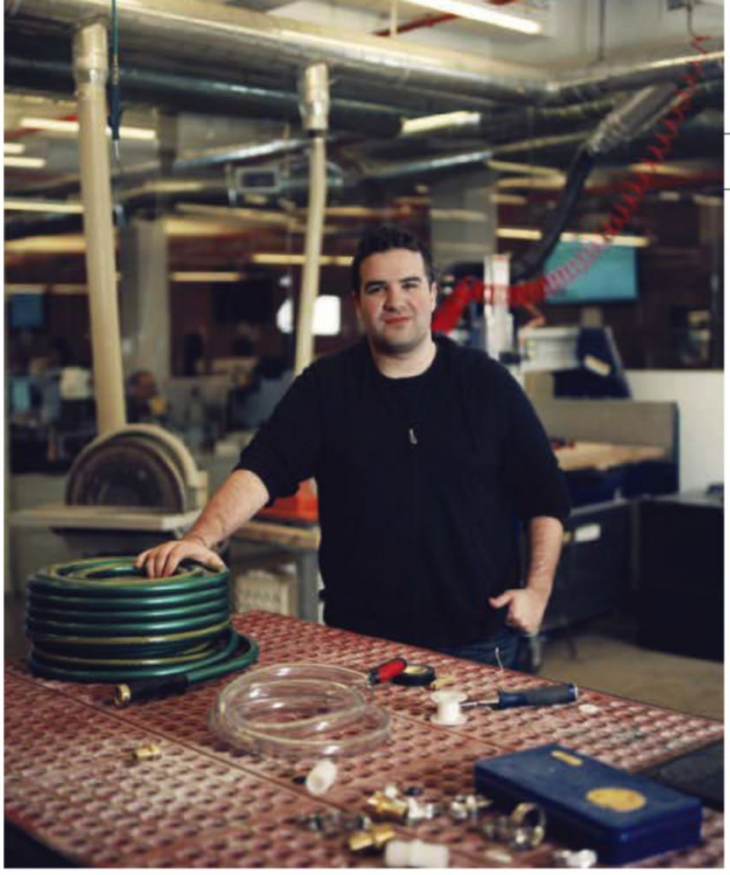
The BumpStep™ protects against bumps, dents and scratches to your vehicle's bumper.

With the BumpStep,™ you will have the reassurance of bumper protection from other motorist's mistakes and small accidents from backing up.

As the "step" portion of its name describes, BumpStep™ also allows you to safely stand on the step (up to a 300lb max) for every day tasks such as loading a roof rack, racking a bike or kayak or washing the upper area of your vehicle.

TO ORDER WeatherTech.com · 800-441-6287

©2014 MacNeil IP LLC



PHOTOGRAPHS BY **RYAN PFLUGER**

INNOVATION ECONOMY • BY CHRIS RAYMOND

Inventors, Inc.

QUIRKY BRINGS NEW IDEAS TO MARKET—WITH HELP FROM ITS ONLINE FRIENDS.

Like many a great invention, Jake Zien's power strip was born of frustration. After completing his junior year of high school, the Milwaukee native was taking a summer course in industrial design at the Rhode Island School of Design when the surge protector beneath his desk, overwhelmed by outsize adapters, invoked his ire one too many times. "I threw my hands in the air and said, damn, I wish I could just stretch this thing out and make 'em all fit," he says. "And then I thought, well, how hard could that really be?"

For his final project, Zien presented his classmates with a novel solution, a power strip that telescoped to make room for larger plugs. Each outlet rotated for added flexibility. The concept later earned him an honorable mention and a T-shirt in a NASA-sponsored Create the Future contest.

The story might have ended there. Zien didn't have the money, the expertise, or the resources to bring the product to life—not even with the help of a family friend who practiced patent law—so his idea remained dormant for four long years as he went off to college at RISD. Then, in 2010, during his junior year, Zien got a call from his lawyer friend, who told him about a startup named Quirky that was searching online for product ideas. While sitting in class, Zien called up the company's website on his laptop, wrote a one-paragraph pitch, attached a few pictures, and submitted an entry fee used at that time to weed out crackpots. "Best hundred bucks I ever spent," he says.

A week later Zien learned that Quirky had decided to produce his invention. And one year and $1 million in development costs later, Pivot Power was for sale in Bed Bath & Beyond for $29.99. It has gone on to become Quirky's best-selling product, a model for what can be achieved when you harness the brainpower of the online universe.

By using the collective might of social networking, rapid prototyping, and advanced manufacturing, Quirky has created what has been described as the world's most innovative consumer products company. "Anyone can be an inventor," says founder and CEO Ben Kaufman. "We truly believe that. We open up invention to the world."

Each week Ben Kaufman and his staff review close to 2000 product pitches from Quirky's online community and choose the top two or three for R&D.

In the course of a week Quirky fields some 2000 ideas—the kind people toss off in the cafeteria over lunch or sketch on a Starbucks napkin—from an online community of 600,000 would-be inventors. Working in small groups, the staff reviews each pitch and whittles the list down to roughly 15. On Thursday nights in the company's New York City headquarters, a former brick warehouse outfitted with weathered wood floors, sleek glass walls, and lofty white ceilings, Kaufman assembles the staff and a handful of honored guests to help him choose two or three winners. (PopMech's Jerry Beilinson is an occasional participant.) The online community observes the entire process on a live Internet feed, offering input along the way. After a few minutes of discussion Kaufman asks for a show of hands from

TAKE BACK YOUR FREEDOM

blu ELECTRONIC CIGARETTES

- No Odor, No Ash
- No Tobacco Smoke, Only Vapor
- On-the-Go Rechargeable Pack



AVAILABLE NATIONWIDE!

Visit us at blucigs.com/store-locator

NOT FOR SALE TO MINORS. blu eCigs® electronic cigarettes are not a smoking cessation product and have not been evaluated by the Food and Drug Administration, nor are they intended to treat, prevent or cure any disease or condition. ©2013 LOEC, Inc. blu™, and blu eCigs® are trademarks of Lorillard Technologies, Inc. (Photography by Francesco Carrozzini)

WHAT'S IN YOUR TOOLBOX?



WHEN something needs to get fixed—whether a leaky faucet or faulty electrical circuit—you're the kind of man who rolls up his sleeves and takes care of business. But to do the job right, you need the right tools.



FROM a sledgehammer and drill to a circular saw and even earmuffs, these are the essential tools you MUST have in your arsenal—with instructions on buying and using each and every one.

AVAILABLE WHEREVER BOOKS ARE SOLD

9781588168726 HEARST BOOKS

the attendees seated in the eight rows of folding chairs in front of him.

If the community responds strongly to an idea—no matter how crazy—Quirky finds a way to make the product, putting its mechanical engineers and industrial designers to work exploring the possibilities. In essence, the concept has already been focus-grouped. "When you understand the problem, that's when the beauty of the design happens," says Doreen Lorenzo, who left the international firm Frog Design to join Quirky as president last October. "A lot of people are giving us ideas based on a problem. And they're living those problems every day."



Jake Zien was a student at the Rhode Island School of Design when he pitched the idea for Pivot Power to Quirky. Within a year, he held a U.S. patent.

The 27-year-old Kaufman knows firsthand what a challenge it is for people to bring their visions to life. At age 17 he convinced his parents to remortgage their home to help finance his first invention—a lanyard that concealed the headphone wires on his iPod shuffle so he could secretly listen to music during high school classes. He spent nearly $185,000 in Shenzhen, China, shuttling from factory to factory, tweaking the design to align with the manufacturing process. The experience paved the way for him to launch the Apple accessory manufacturer Mophie at age 19. He eventually lost control of the company in a battle with investors.

Undeterred, Kaufman holed up with a few friends in an apartment in Manhattan's East Village in 2009 to hatch the plan for Quirky. From the start he made it his mission to tear down the barriers to innovation.

Quirky's in-house design team has more than $2 million worth of prototyping equipment: 3D printers, CNC milling machines, vacuum-forming machines—the works. Staff experts handle patent questions, regulatory issues, and sales. The company has also received $30 million from GE as part of a five-year deal to release 30 co-branded products using Quirky's open-source WINK software, which lets consumers operate household items from a mobile phone app. Think lawn sprinkler and garage door opener. Quirky has even built an online platform to share 30,000 GE patents with the public. "By opening up lab-proved technology and patents to everyday inventors," GE senior vice president Beth Comstock says, "we can help inspire new ideas."

They don't have to be big ideas. All told, 853 online contributors, or "influencers," played a role in perfecting Pivot Power's design, packaging, and marketing materials—and each received a small stake in the royalties. That interaction is critical: Quirky genuinely listens to what its community has to say. Kaufman cites as an example the app-enabled WINK egg tray. It originally had a dozen cups for eggs, because, well, grocery stores sell eggs by the dozen. But the influencers pointed out that people buy fresh eggs when they get down to the last two. And so, the egg tray went to market with 14 cups. "That's the power of doing things the way we do them," Kaufman says. "The fact we're in people's living rooms, understanding the real-world implications of the things we're inventing, has enormous value."

Few companies in the world are set up to innovate at the pace Quirky has established. Kaufman now has 150 employees to help him develop three

new products a week. "Our speed here is unbelievable," says Josh Wright, who was one of the community's first influencers, conceived two inventions, and then moved his family from Florida to New Jersey to work as a jack-of-all-trades at Quirky. "We've had nights where we crank out five working prototypes—from idea to something you hold in your hands—in 14 hours. That includes design, 3D printing, electrical engineering, assembly, painting, and having the thing ready to go on an airplane for a retailer demo."

"We are only slowed by things that are not within our control," Kaufman says. "That's the ethos of the team here: We move as quickly as possible."

Indeed, Zien—now the lead graphic designer at a startup named Floored, which creates 3D-modeling software for the real estate industry—is still awed by the turn of events in his life. Less than three years out of college, he has his name on a U.S. patent. He appeared in Quirky's six-episode TV show on the Sundance Channel. His picture can be found on Pivot Power packages worldwide. His product has inspired a series of spinoffs. And then, of course, there's the matter of his mushrooming bank account. As the 2013 holiday shopping season approached, Quirky had sold close to 700,000 units of his pivoting power strip, earning him more than $400,000 in royalties. The company predicts he will reach $2 million before 2014 is out.

"People are like, oh, so why do you have a day job?" Zien says. "And I'm like, because I'm 24 years old and I have a career ahead of me."

The truth is, all this good fortune makes him a little self-conscious. "I would prefer to be private about it," he says. "I have friends paying off student loans and stuff." **PopMech**



YOUR FREE PEARLS ARE HERE

EXPERIENCE THE LUXURY OF MITSUKO ORGANIC CULTURED PEARLS REGULARLY $299, GET THEM TODAY FOR FREE*

We owe you an apology. This exclusive deal is guaranteed to ruin every jewelry purchase you make from now on. Once you realize that it's possible to own a genuine cultured pearl necklace for **FREE**, other luxury brands are bound to disappoint. They can't handle **FREE** jewelry. They can't even afford to try. But you can. And that's all that matters to us.

We're offering our ***Mitsuko Organic Cultured Pearl Necklace*** online for $299. But if you'd like it for near **NOTHING** (you pay only the $19.95 shipping & processing–*see details below*) all you need to do is call 1-800-859-1542.

It's okay to be skeptical. You have every right to be. Why would any company give away a pearl necklace? Good question. We believe that once you try us, you'll be back for more. But maybe a better question is why other luxury jewelers don't think twice about offering cultured pearls for hundreds—even thousands—more. I'm sure they have their reasons. But you don't have to fall for them. Not anymore. Call today for your **FREE *Mitsuko Organic Cultured Pearl Necklace*** and you'll realize that luxury doesn't have to cost a fortune.

Mitsuko Organic Cultured Pearls—Exclusively from Stauer. Every necklace is the product of generations of expertise. From natural genesis to final selection, imported Mitsuko organic cultured pearls are held to the highest standard. This continuous, 26" strand showcases a collection of 6½-7mm white cultured pearls. Each necklace is hand-strung and double-knotted to keep every precious pearl secure.

This exclusive FREE offer can't last forever. Unfortunately, we are only able to make a limited number of these necklaces available to the public for free. Don't let this incredible opportunity pass you by! To ensure that you receive your ***FREE Mitsuko Organic Cultured Pearl Necklace***, please call today. Your idea of luxury will never be the same!

Mitsuko Cultured Pearl Necklace Regularly ~~$299~~†

Yours FREE*

***Pay only $19.95 shipping & processing**

ACCREDITED BUSINESS BBB Rating of A+

Call now while our supplies last...

1-800-859-1542

Promotional Code MFP177-01
Please mention this code when you call.

Stauer®
14101 Southcross Drive W.,
Dept. MFP177-01
Burnsville, Minnesota 55337
www.stauer.com

* This offer is valid in the United States (and Puerto Rico) except in TX, FL, CO, OK, RI, NH, WV and ID. These state residents will be charged one cent ($.01) + shipping & processing for the item. Void where prohibited or restricted by law. Offer subject to state and local regulations. Not valid with any other offers and only while supplies last. This offer is limited to one item per shipping address.

† Free is for Call-In Customers only versus the original Stauer.com price.



UAVs with cameras provide data that helps farmers monitor their crops.

10 Tech Terms For 2014

WHAT PEOPLE IN THE KNOW WILL BE TALKING ABOUT THIS YEAR.

1.

Farm drones

That sound you hear is a swarm of drones, revving their tiny engines as they wait for the Federal Aviation Administration to update its rules on commercial UAV flight. The biggest beneficiaries may be farmers who hope to use cheap UAVs armed with cameras to monitor the health of their crops, employing aerial photography—digital and infrared—to fine-tune delivery of water, fertilizer, and other chemicals. To tap that hungry market, companies such as Indiana-based PrecisionHawk have developed simple plug-and-play sensors and data-processing software for use with their 3-pound GPS-guided Lancaster UAV. For now the FAA rules governing farm use are vague (no one has gotten into trouble yet), but the agency is expected to clarify things this year and issue final rules in 2015.



2.

In-memory computing

In traditional computer architecture, there's memory (the 6 GB of RAM in your laptop that provides lightning-quick access to the data required to run your applications), and then there's storage (a 1 TB hard drive, slow and inefficient to access but spacious enough to archive your many files). The same dichotomy holds true for massive-data centers, which makes it hard to analyze big-data sets without the delays inherent in retrieving each piece of data from the clunky spinning disk where it's stored. But now that flash memory is relatively inexpensive and getting cheaper by the year, companies such as SAP and Oracle are experimenting with a radical alternative: stowing all your data right in memory. This in-memory computing offers dramatic increases in speed and, by some estimates, energy savings of up to 80 percent for big-data centers.

With the release of Violin Memory's inexpensive in-memory storage cards, individual servers can now take advantage of those benefits too.

3.

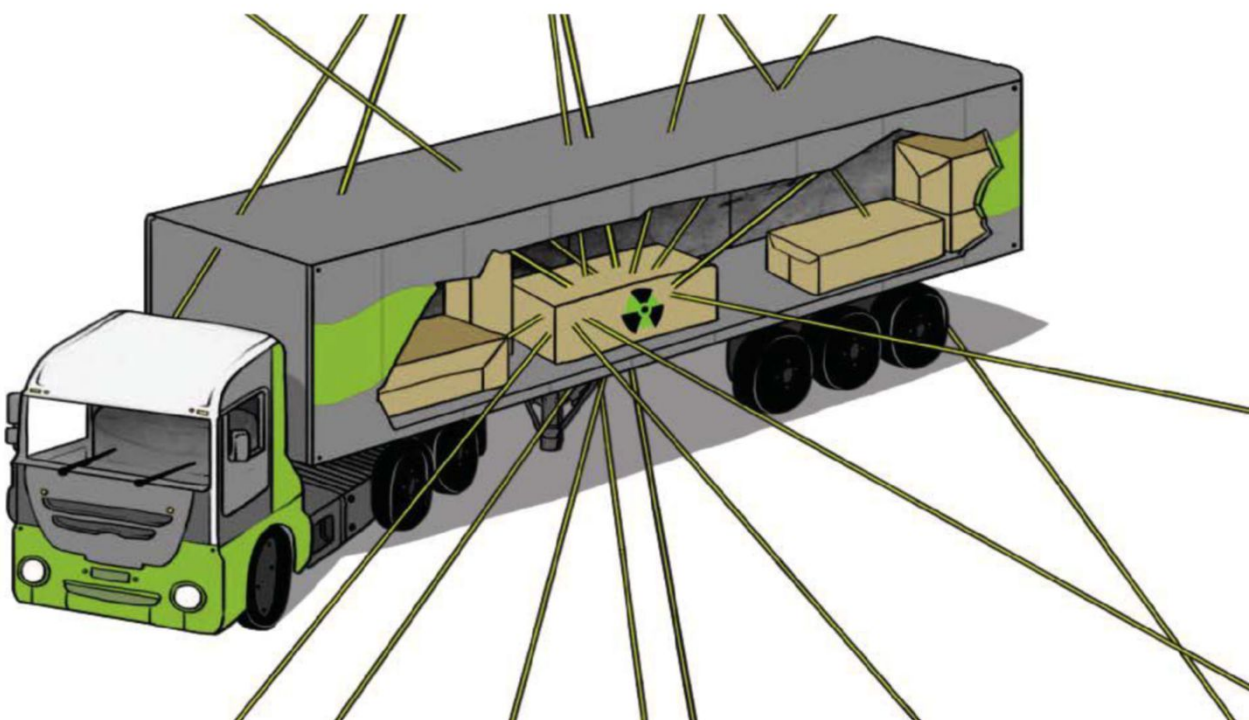
IPv6

In February 2011 the Internet officially ran out of IP addresses. You probably didn't notice, because new devices continue to connect to the Web via address-sharing work-arounds. But those are stopgap measures. It's time for a wholesale shift from the 32-bit, 4.3-billion-address IPv4 system developed in the 1970s to the 128-bit IPv6 and its mind-boggling 340 trillion trillion trillion addresses. To complete the change, every website and Internet provider has to buy in, updating equipment when necessary. At the moment only about 2 percent of Google's traffic arrives via IPv6. Will the world get its act together in time to avoid missed connections? Many holdouts are looking to Washington for the answer: The White House has mandated that all government servers switch to IPv6 by October.

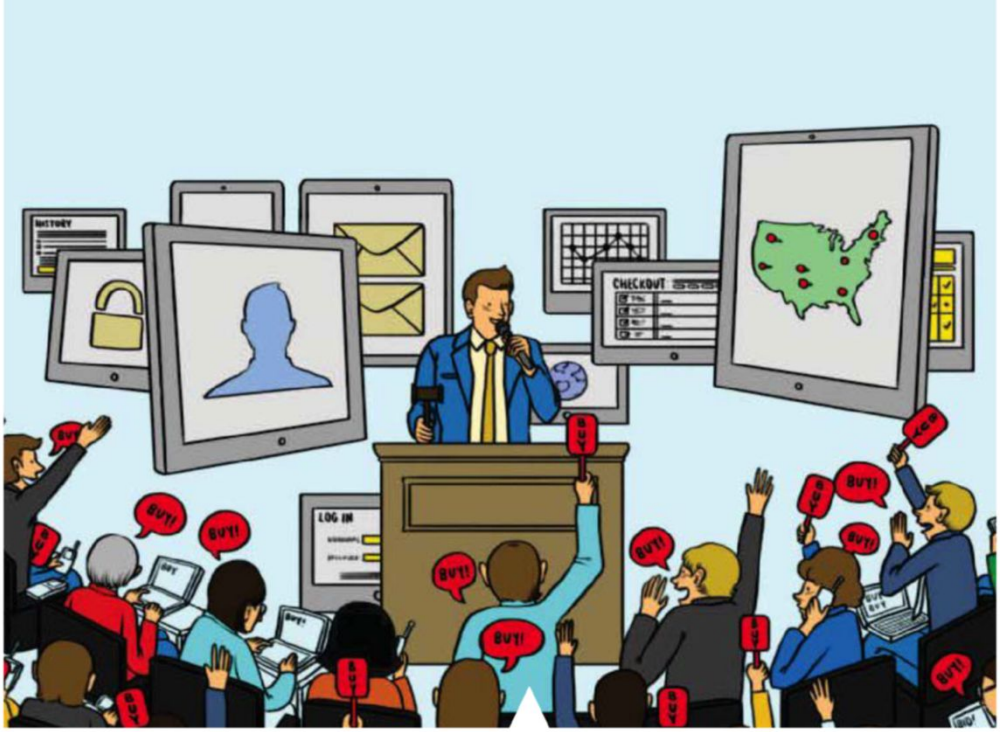
4.

Muon tomography

Though very similar to computed tomography (better known as CT scanning), muon tomography offers one key advantage: Instead of assembling images with radioactive X-rays, it uses particles created naturally in the upper atmosphere by the cosmic rays that constantly bombard Earth. These particles, known as



Decision Sciences' scanning system uncovers nuclear threats by tracking the movements of muons, which penetrate much more deeply than X-rays.



muons, penetrate much more deeply than X-rays, which means they can pass through shielding materials like lead—and that makes them perfect for detecting nuclear material hidden in shipping containers. Virginia-based Decision Sciences, working with Los Alamos National Lab, has developed the Multi-Mode Passive Detection System, which can scan a 40-foot shipping container in 30 seconds, looking for the telltale ways in which muons are deflected by uranium and plutonium. And before year's end, the company plans to introduce a software upgrade that will enable the device to detect conventional electronics and other contraband. It comes as no surprise that the departments of Defense and Homeland Security have already signed up to use the technology.

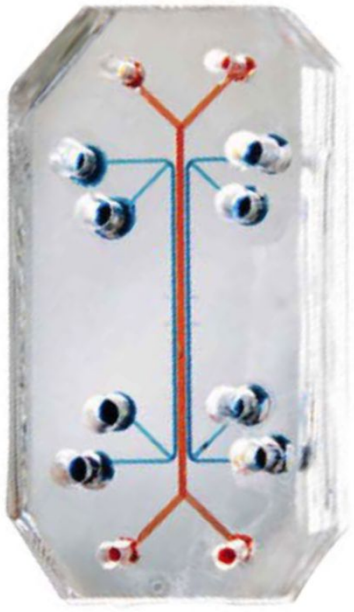
5.

PERSONAL-DATA AUCTIONS

In 2000 a public outcry forced Yahoo and eBay to cancel their plans to auction personal data collected from 200,000 people by a marketing company. Today that data is more accessible and more valuable than ever, but people still strive to protect it.

Going once, going twice . . . Startups such as Personal are developing online marketplaces where consumers can collect and sell their personal data in return for cash and deals.

Public sentiment may be changing, though. Last year an NYU student served up two months' worth of private data mined from his digital devices in a Kickstarter campaign. The stunt raised $2733 from 213 amused backers. Now startups such as Washington, D.C.–based Personal are betting that others will follow suit, lumping their online accounts together in one place for convenience and for profit. Once their data is collected, they can choose whether to part with chunks of it—in exchange for special deals and other enticements, that is.



The lung-on-a-chip mimics the mechanical and biochemical functions of a living, breathing organ.

6.

Organ-on-a-chip

Drugs that work well in a petri dish—or even in a mouse—often turn out to be ineffective or dangerous in humans. That's why researchers at Harvard's Wyss Institute for Biologically Inspired Engineering set out to create computer chips capable of simulating the functions of real organs. The lung-on-a-chip has a membrane lined with human lung cells on one side and blood-vessel cells on the other. Air flows across the lung-cell side and a blood-like liquid flows across the other. The device even expands and contracts as it "breathes." Scientists are currently working with the Food and Drug Administration to test counter-radiation drugs on bone marrow, gut, and lung chips. The

next step is bolder yet: a $37 million DARPA-funded plan to link various chips in what amounts to a whole-human-body-on-a-chip.



PHOTOGRAPH BY KIMMO ERVOLA (GLASSES)

7.

3D counterfeiting

In February a series of 3D-printer patents will expire, clearing the way for a flood of cheap professional machines. That's good news for small manufacturing shops but bad news for companies that make highly desirable—and easily copied—objects such as jewelry and sunglasses. Rogue websites like thepiratebay.sx have already added sections to distribute the printing specs, pulled from pirated blueprints or 3D scans of the originals, for such objects. While designers wrestle with how to insert digital rights management codes in 3D-printer files, some experts predict that by 2018 companies will be losing $100 billion a year in intellectual property. The more immediate issue for everyone, though, is figuring out exactly what is protected by copyright (for creative work) and patent (for useful devices). A screw? No big deal. A replacement part for your car? That's trickier.

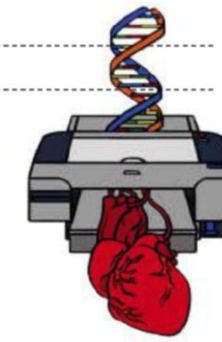
8.

SEMIAUTONOMOUS DRIVING

We still have a way to go before cars pilot themselves to the office, but, little by little, technology is now assisting us with the driving. Ford, Audi, and Volvo have designed vehicles that can park themselves. GM's hands-free Super Cruise control will adjust the steering and the brakes to keep your car at a safe remove from the SUV ahead. The Direct Adaptive Steering system in Nissan's Infiniti Q50 uses circuits to sidestep the rack-and-pinion system, speeding up the response time between steering wheel and tires, maybe even paving the way for vehicles operated by joysticks. Cool? You bet, but advances like these also have the potential to make for safer roads, fewer bottlenecks, and, yes, hands idle enough for you to enjoy a donut with your coffee.

9.

Bioprinting



Imagine taking an inkjet printer, filling it with bio-ink made from stem cells, and printing a new kidney for anyone who needs a transplant. The process is a little more complicated than that, of course, particularly when working with multiple cell types or tubular structures, but after years of research that incredible scenario is almost within our reach. San Diego–based Organovo, which unveiled the first commercial 3D bioprinter in 2009, expects to release functional human liver tissue in 2014 that drug companies can use for medical research. Scientists are also working on printable bone and wound-healing materials. It's still a big leap from there to a fully transplantable organ, but take heart: Now you don't have to be a science-fiction fan to believe it's possible.



10.

Active cyber defense

Even the walls of classified military networks are vulnerable to hackers. So in 2012 DARPA launched an Active Cyber Defense program. Think preemptive strikes. Proponents aim to identify and disarm would-be attackers with, say, fake data. The startup CrowdStrike is bringing the same aggressive approach to the private sector, promising to use big-data analytics to monitor real-time activity in client networks. Some advocates are even pushing for changes in privacy laws for permission to hack into an adversary's network to retrieve or destroy stolen data. **PopMech**

THE DIGITAL SPIES ARE WATCHING YOU—MARKETERS, THE NSA, IDENTITY THIEVES, ALL KINDS OF SNOOPS. BUT THE BATTLE'S NOT OVER. HERE ARE SEVEN BIG CATEGORIES OF PERSONAL TECH, AND HOW YOU CAN SECURE THEM.



IT'S TIME TO FIGHT FOR YOUR

PRI

PRIVACY, WE SAY, is about to come roaring back. No, it's not too late. Yes, we know that Google monetizes both our emails and our search histories. It's true that data brokers market our personal dossiers, listing everything from our favorite blogs to our old parking tickets (identity thieves must love it). And NSA leaker Edward Snowden really did prove the paranoids right: The United States government spies on everyone. Now, we agree that security agencies have a vital responsibility to track terrorists, but that mission can't require all citizens to live in a surveillance state. Feel you have nothing to hide? That assumes the data will always be used to defeat terrorists, not to monitor activists, let alone to stalk ex-girlfriends—yes, NSA employees have done that. Here's the other side to the privacy-is-dead argument. You can fight the privacy erosion that technology has enabled using tools that technology provides. And when you protect your data—using encryption and other tools—you incidentally bolster the argument that security is the norm. At least it should be. Privacy is not dead but simply suffering from neglect. It's your job to revive it.



BY **DAVEY ALBA**

PHOTOGRAPH BY **TERU ONISHI**
PROP STYLING BY SARAH GUIDO

TECH: WEB BROWSERS

TO DO: DEFEAT TRACKING SOFTWARE

Web browsers work in two directions: You use them to learn about the world, and snoops use them to learn about you. The sheer number of identifying files, or cookies, downloaded onto our computers can surprise even jaded digital natives. Many cookies are helpful—keeping you logged in to a service, for instance—but others exist purely to help marketers target their sales pitches. An online tool maintained by the Network Advertising Initiative can reveal who is collecting information on you; a browser we tested was being tracked by 82 firms, with

•

TYPOGRAPHY BY SINELAB

names such as AppNexus, Criteo, and Datalogix.

Cookies can be cleared, but new methods for tracking online use will be harder to circumvent. For instance, some companies use browser fingerprinting, which looks for distinctive patterns of computer settings, such as installed fonts and time-zone details, to home in on a user's identity. Google and Microsoft are also working on a new form of cookie-less identification: unique IDs with tracking that reaches beyond the desktop and into the user's browsing activities on smartphones and tablets. Google's system potentially could be used to tie together data across all its products—Gmail, the Chrome browser, and Android phones. In addition to tech firms, the U.S. government can monitor your digital trail through your browser. Among last year's revelations: The NSA has tapped into the fiber-optic cables that make up the Internet's backbone, and, through the Marina metadata application, the agency can track an individual's browsing history, social connections, and, in some cases, physical locations.

Routine fix: To practice good browser hygiene, regularly clear your cookies and your browser cache. There are a number of browser add-ons that can shrink the deluge as it pours in. For instance, AdBlock Edge blocks ads and third-party trackers. The Disconnect add-on lets you see and prevent otherwise invisible tracking of your browsing history. (Both add-ons work with Firefox and Chrome; Firefox is preferable because it's an open-source browser.) **Extreme fix:** Organizing resistance to a totalitarian state and need real anonymity? Download the Tor Browser Bundle. Tor has become famous as a secure way for activists, journalists, and, yes, some criminals to browse the Web. Tor bundles your data into encrypted packets and directs it through a worldwide volunteer network of more than 3000 servers, hiding your location and making your data more difficult to read along the way.

There are two downsides to Tor: First, it's slow, because your data is sent through at least three relays, with each relay donating different amounts of bandwidth to Tor users. Second, merely downloading it can draw government scrutiny. The NSA has reportedly developed a system called FoxAcid to insert eavesdropping applications into the machines of Tor users. However, the agency admitted in a leaked Snowden document, "We will never be able to de-anonymize all Tor users all the time." A virtual private network (VPN) adds a different kind of protection by encrypting all outbound computer communications. Combine Tor with a VPN and you've got even tighter security.

TECH: SOCIAL NETWORKS

TO DO: RAMP UP PRIVACY SETTINGS

In 2011 an Austrian law student named Max Schrems asked Facebook to provide all the data it had collected on him, taking advantage of an obscure provision in a European data-protection law passed in 1995. Schrems initially received only a fraction of his data. He protested, and eventually a CD showed up at his door that held a 1222-page PDF, which included employment information, relationship statuses, pokes, old chat conversations, and geotagged photos—most of it information that Schrems thought he had deleted. Such data is being monetized by tech companies in increasingly invasive ways. Google's Shared Endorsements feature, for instance, allows the company to



E-ZPass tags capture a car's location data at toll plazas. The information can be used in civil court cases, such as divorces. Tag readers can also be used to monitor traffic flow along any road.

PHOTOGRAPH BY ASSOCIATED PRESS

ILLUSTRATIONS BY **AMANDA LANZONE**

PRIVACY MAKEOVER

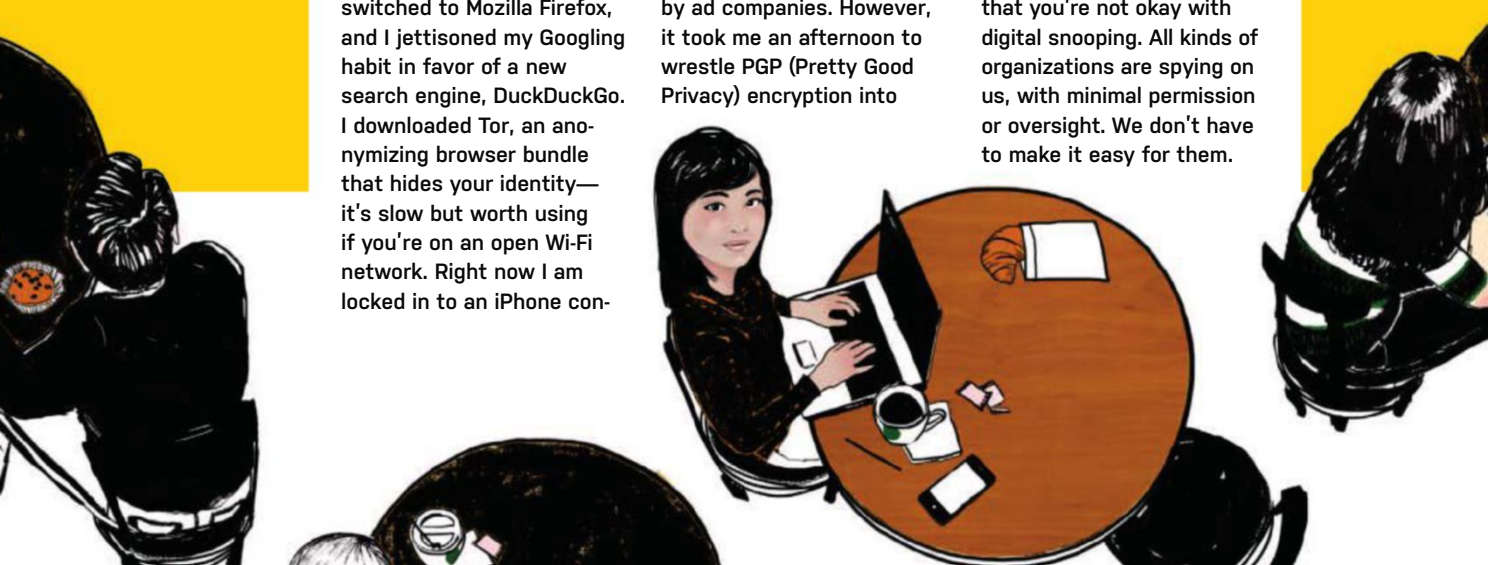
HOW POPMECH TECH EDITOR DAVEY ALBA TRIED FOR TOTAL DIGITAL SECURITY.

PROUD TECHNOPHILE—that's how I'd describe myself. I've built a 3D printer from mail-order parts. I once tracked down an iPhone thief using sneaky digital tools. My smartphone, at last count, has 303 apps. But testing seemingly every digital product released has a downside: It means I have bigger privacy vulnerabilities than most people. And for all the attention I pay to technology, I've never worked particularly hard at protecting my data—I always used default privacy settings and the same, sloppy online tools most people choose. No longer. After interviewing dozens of computer science researchers, cryptographers, and security professionals and learning how easily digital snoops can access personal data, I decided to change my ways. Every expert's top suggestion: Use open-source software, because the NSA works with tech companies to weaken encryption in proprietary software. "It's much harder to build in back doors in open-source," Matthew Green, a computer security expert at Johns Hopkins University, told me. "The eyeballs are on it." I switched to Mozilla Firefox, and I jettisoned my Googling habit in favor of a new search engine, DuckDuckGo. I downloaded Tor, an anonymizing browser bundle that hides your identity—it's slow but worth using if you're on an open Wi-Fi network. Right now I am locked in to an iPhone contract, but next time I'll go with Android, which is open-source. So far, so easy.

Next, I set about installing encryption software on my laptop and phone. Honestly, I'd never even heard of some of the tools my sources recommended—with names like Cryptocat, Autistici/Inventati, and GNU Privacy Guard. Downloading a secure instant-messaging client was a cinch. So was adding plug-ins to my browser to block tracking by ad companies. However, it took me an afternoon to wrestle PGP (Pretty Good Privacy) encryption into my email, partly because I insisted on learning how to encrypt my Facebook messages too. I started using a password manager, then promptly forgot the long master password I'd created. But I worked through the mishaps and felt much more secure once I was done.

But there was a rub: Privacy is a lonely world. I had an encrypted phone service and text messaging—and no one to talk to. The first time I fired up my secure texting app, Silent Text, I had exactly one contact on my list: Bruce Schneier, the cryptographer who'd recommended it. But rather than give up, I started cajoling my friends into enabling encryption on their own systems so that we could communicate. (I probably have lots of invisible new friends too. The NSA reportedly flags people who download encryption software—I imagine I'm now on the agency's radar.)

Is increased security worth the trouble? I say yes. Realistically, it may be hard to adopt some of these tools, the ones that require your friends to sign up as well. But if there's ever been a time to advocate for privacy technology, this is it. Downloading encryption tools sends a clear message that you're not okay with digital snooping. All kinds of organizations are spying on us, with minimal permission or oversight. We don't have to make it easy for them.



DIGITAL SAFETY ZONES

Where do you land along the privacy spectrum? Side with the easy-going online libertines and you'll never have to remember another password—but everyone from spambots to NSA spooks will have their way with you. Join the Luddite camp, avoiding all digital entanglements, and you'll be safer but isolated. Most of us will be happiest somewhere in the middle. Choose wisely, digital dweller.

The Man With No Secrets —at All

Security level: 1

Profile: You're a digital exhibitionist—and an identity thief's perfect target.
Digital tech: One password to rule them all (last four of your Social Security number should do it); unsecured Wi-Fi; phone Password Lock set to Off.
Social networks: Facebook, Snapchat, Pinterest, Twitter, Instagram—you name it. Privacy settings? What are those?
Commerce: The more retail loyalty programs you can join, the better you like it.



include a Google Plus user's name and photo alongside ads being shown to his social contacts, if the original user had indicated some interest in the product. And potentially such data could also be pored over by recruiters, cybercriminals, and stalkers.

Routine fix: Use strong privacy settings on each of your social networks, placing limits on who can see your posts. To block tracking software associated with the Share buttons on many websites, install Disconnect, an extension that disables such widgets. Also, log out of social networks when you're finished, and routinely clear cookies. **Extreme fix:** Opt out of social media—invite your friends to a barbecue.

TECH: AUTOMOBILES

TO DO: GET USED TO IT

In early 2012 a tinkerer with the Internet alias Puking Monkey hacked a plastic "moo cow" toy to sound an alarm every time his E-ZPass was read. This RFID-enabled device is used to pay bridge and highway tolls throughout much of the East. But during a test drive in July 2013 the cow lit up and wailed in Manhattan, even when the car was nowhere near a toll plaza. The unseen E-ZPass readers had been installed to help monitor traffic flow—but that didn't pacify the hacker. "If nontoll tracking is benign," asks Puking Monkey in an email, "why is it not disclosed when you sign up for an E-ZPass?"

There are ways to avoid that kind of tracking. But you can't do too much about the really big guns of automotive surveillance: the tens of thousands of automatic license-plate scanners deployed across the country. In Grapevine, Texas, to give one example, 14,547 vehicles were photographed in one day, and up to 2 million plates are currently stored in a database. Most law enforcement agencies can still set their own policies on the use and retention of the data (it varies by state); many

ILLUSTRATIONS BY AMANDA LANZONE

You Floss Nightly—and Clear Your Web Cache

Security level: 2

Profile: Sure, you know the NSA and Target are both listening in. Creepy? Sort of. You'll take precautions—but you're not giving up Scramble With Friends just to make a point.
Digital tech: For Web browsing, privacy add-ons (e.g., HTTPS Everywhere, Disconnect); for email, two-step verification and strong passwords; WPA-encrypted Wi-Fi.
Social networks: All networks, but with strong privacy settings and a password manager.
Commerce: Amazon Prime, baby . . . You can't give up everything.

Paranoid? No, Realistic

Security level: 3

Profile: They laughed at your talk of government surveillance, but that was before Edward Snowden. Who's paranoid now?
Digital tech: VPN (virtual private network), OTR (Off The Record) instant messaging for laptops, and Silent Circle for mobile phone calls; PGP (Pretty Good Privacy) email encryption.
Social networks: Offline only—you meet your buddies at the Def Con Hacking Conference.
Commerce: No loyalty cards; you give "Jenny's Number" (XXX-867-5309) to store clerks to look up "your" account.

Welcome To the Encrypted Zone

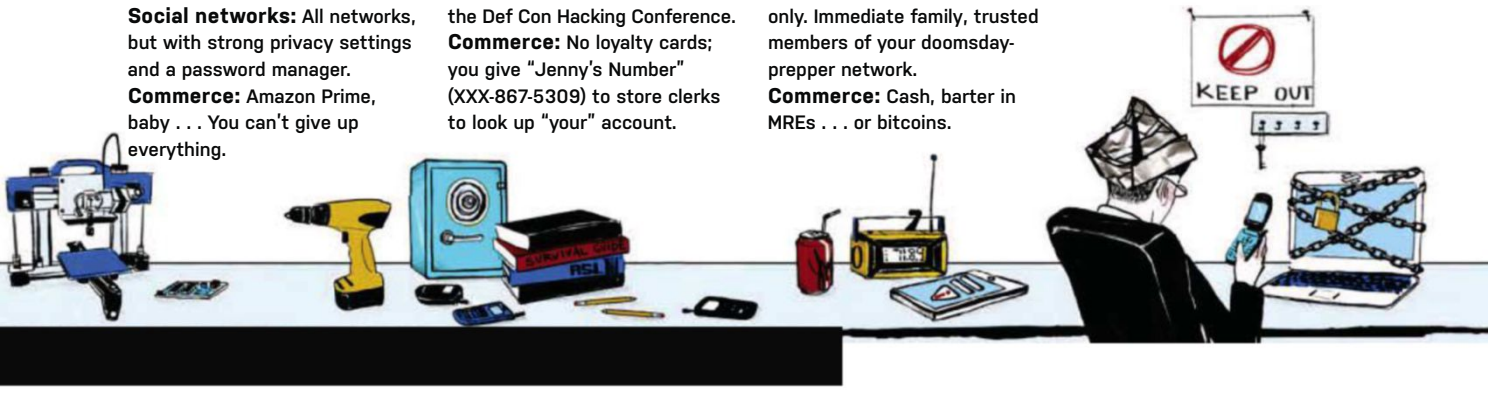
Security level: 4

Profile: You're a CIA agent or democracy activist in a totalitarian state. Or maybe you just think like one. Welcome to the privacy rabbit hole.
Digital tech: Air-gapped computers (meaning no Web connection) for sensitive files; burner phones; the Tor bundle with VPN. Open-source technology.
Social networks: Offline only. Immediate family, trusted members of your doomsday-prepper network.
Commerce: Cash, barter in MREs . . . or bitcoins.

Living Off the Grid, Under A Rock

Security level: 5

Profile: You don't want to worry about digital snooping—ever. So you've gone offline.
Digital tech: Does finger painting count? Absolutely no computers.
Social network: Other woodland creatures, your reclusive aunt.
Commerce: Cash, foraging for edible roots.



have no policy at all. In addition to all this, cars are themselves data-sharing devices—electric cars can upload data to their manufacturers, and connected services such as GM's OnStar and the Ford SYNC infotainment system send information to the cloud. But the most widespread in-car device is the event data recorder (EDR), which tracks seatbelt use, speed, steering, and braking, among other bits of vehicle data. This data comes into play during accident investigations. Ninety-six percent of cars built in 2013 have the devices; they will be required in all new cars starting next September.

Routine fix: You can store RFID devices such as an E-ZPass in a read-prevention holder until you get to a tollbooth. Or simply pay cash—though that option is going away on some roadways. There's a lot of chatter about techniques to defeat license-plate cameras, but it's unclear whether these are legal or even effective. **Extreme fix:** When it comes to black boxes in cars, the best approach is to know your legal rights—or, better yet, just to drive safely. Really hate being watched? Buy an old car that predates black boxes.

TECH: INSTANT MESSAGING

TO DO: CLEAR OLD CHATS

Instant messages seem fleeting, but they're not. The messages are stored, at least briefly, on the IM service provider's servers, and, unless you delete them, on your machine and your partner's. And unencrypted messages are vulnerable to interception as they travel from your device through your ISP's network to your IM service provider (Google, AOL, Yahoo, Microsoft, or whomever) and then out to your friend's computer. But does anyone actually snoop on IM conversations? Well, the U.S. government does, for one. Snowden leaks reported in July 2013 revealed the existence of XKeyscore, an NSA program run in cooperation with security

agencies in New Zealand and Australia that, among other things, lets agents surveil IM correspondence, often in real time.
Routine fix: Delete your chat records, in case anyone gets hold of your phone or laptop. You can stop recording future chats by changing the settings in your IM client. **Extreme fix:** The gold standard in IM encryption is OTR, or Off The Record (not to be confused with Google's proprietary Off The Record chat feature, which isn't secure). OTR uses "perfect forward secrecy," which means a fresh set of encryption keys is created every time one partner in the chat sends a new batch of messages. Note: Even participants in the chat won't be able to review old messages. As Ian Goldberg and Nikita Borisov, the designers of the OTR protocol, explained in an email, "The only record of the conversation is your memories."

TECH: EMAIL

TO DO: TURN ON OPTIONAL SECURITY TOOLS

ADI KAMDAR, ELECTRONIC FRONTIER FOUNDATION



The content of your emails can be less revealing than the metadata—the record of which contacts you correspond with and how often. Through a program called Stellar Wind, the NSA logged metadata on email communications for 10 years, and from 2007 to 2011 the data included bulk information on Americans. In a separate effort, the government agency has been scooping up hundreds of millions of contact lists from around the world, at a rate of 250 million people a year.

"TOO OFTEN THE DISCUSSION ABOUT PRIVACY DIGRESSES FROM THE ISSUE OF CONTROL. PEOPLE DESERVE THE POWER TO KNOW WHAT'S GOING ON, AND TO SAY NO OR SET LIMITS ON WHO CAN USE THEIR DATA. MAKING SURE GOOD CHECKS ARE IN PLACE IS SOMETHING THAT WE, AS BOTH CITIZENS AND CONSUMERS, CAN AND SHOULD FIGHT FOR."

One piece of fallout from that spying has been the shuttering of two services that until recently offered a high level of protection—not just against the United States government but also against repressive regimes and criminal organizations. Ladar Levison, the owner of Lavabit, a Texas-based secure email service, closed down operations in August after he was asked to hand over the encryption keys that protected his site to the FBI, which would have given the government access to all user data. The FBI said it was just interested in Lavabit's most famous user, Edward Snowden—but refused Levison's offer to provide access to that account only. A few hours later the encrypted communications company Silent Circle announced that it, too, was closing its email operations because, while the messages sent through its service were encrypted, email protocols—SMTP, POP3, and IMAP—leave user metadata open to spying. "We decided that our email service was too much of a risk for us and our customers," Silent Circle's Jon Callas says. "While it might have been a good idea six months before, it wasn't a good idea in a post-Snowden world." The companies have since teamed up to develop a new service, called Dark Mail, meant to secure both the content of an email and its metadata—the encryption will only work among Dark Mail users.
Routine fix: Ordinary email protocols make it impossible to hide metadata information, but there are ways to secure the content of your messages. Check that you're using the common Internet security protocols, SSL and TLS, when you're on webmail. (The browser's address line will start with https, and a small padlock appears.) If you're using a desktop mail client, make sure you're connected via SSL/TLS over IMAP or POP; otherwise your emails are being sent in cleartext and can be read by outsiders. Also, turn on two-factor authentication, a security feature offered by the three big email services, Gmail, Yahoo, and Outlook (see "5 Email Myths Debunked," p. 82, for additional routine email-security measures). **Extreme fix:** People who truly need to guard their communications use PGP (Pretty Good Privacy) when they email each other. Every user has a pair of cryptographic keys, a public encryption key, and a private decryption one. The public key is widely distributed, while the private key is kept by the owner. A sender encrypts his or her note with the recipient's pub-

lic key, transforming it into gibberish. Since only the sender and receiver hold the keys, no one in the middle—including the email service provider—can decode the message. PGP doesn't hide the metadata, though, and everyone you communicate with has to be using PGP for it to work.

TECH: MOBILE DEVICES

TO DO: DELETE OLD APPS

There's no need to invent the ultimate citizen-surveillance device: It already exists, and it's called the smartphone. Police departments have been investing in IMSI catchers (that's short for International Mobile Subscriber Identity). These devices insert themselves between mobile devices and cell towers—the technology can be used to identify participants at a demonstration and even access their conversations. Hackers can build or buy the devices, as well. Additionally, law enforcement agencies can easily subpoena third-party companies for user data; in 2011 cellphone carriers responded to an astonishing 1.3 million demands for subscriber information. The companies handed over text messages, caller locations, and other information, in most cases without the knowledge of the user. Brick-and-mortar retailers are also making use of cellphone-location data: Some chains have started experimenting with using phones to track individual shoppers as they move through the store. And many mobile phone apps can transmit location data, contact lists, and calendar information back to their developers. Lose an unlocked phone and, of course, you give up access to your contact lists, emails, chats, and everything else that resides on your phone.

Routine fix: First, delete the apps you don't use—fewer apps means fewer robotic spies.

Extreme fix: Silent Phone can encrypt phone calls ($10/month, iOS and Android)—both parties need to be subscribers. There are also secure apps for IM chats and Web browsing. Prepaid, or burner, phones are relatively safe from snooping because they aren't tied to an account. And if you're worried about IMSI catchers at your next political rally, just leave your phone at home.

TECH: WI-FI

TO DO: USE ENCRYPTION

We all know that browsing on an unsecured network is just asking for someone armed with cheap network-analyzing software to tune in by vacuuming the 802.11 data packets flying between your machine and the Wi-Fi router. That can happen in Starbucks—or in your home. Last September a federal appeals court ruled that Google could be held liable for civil damages for eavesdropping on homeowners' Wi-Fi networks while using the company's camera-carrying Street View cars. Google says it was all a misunderstanding: The Wi-Fi data was being used to pinpoint precise locations where GPS signals were spotty.

Routine fix: Most wireless Internet access points come with WEP (Wired Equivalent Privacy) or WPA (Wi-Fi Protected Access) to let you encrypt the messages between your computer and your access point. Use WPA if possible; it's the stronger technology. In addition to protecting your data, turning on encryption gives you legal protection against hackers under the Wiretap Act, which Congress passed in 1968 and last amended in 1986 through the Electronic Communications Privacy Act (ECPA). If you don't make any attempt to secure your data transmissions, the law assumes that your intention is to run a public network.

Extreme fix: Combine a virtual private network with the Tor bundle and you're as safe as you can be—well, almost. Want even better security? Don't use Wi-Fi at all. **PopMech**



Burner phones, prepaid devices that aren't tied to a specific account and allow people to switch numbers frequently, can be useful tools for the highly cautious.

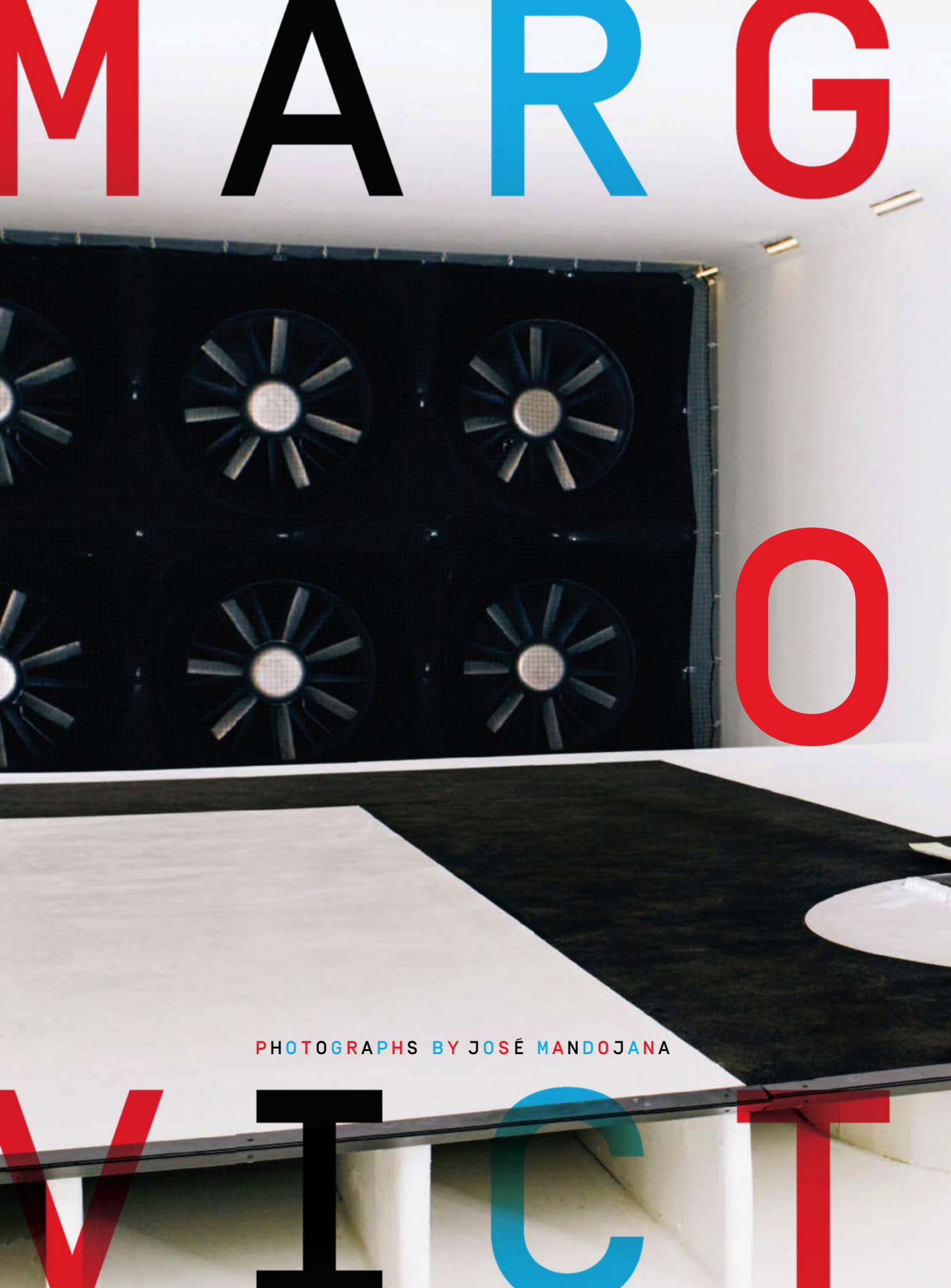




License-plate readers (left), mounted atop patrol cars and along city streets, scan up to 1800 license plates per minute—keeping track of virtually every car on the road.

PHOTOGRAPHS BY ASSOCIATED PRESS (CAMERA), PHILIP FRIEDMAN (PHONE)

MARGO VICT



PHOTOGRAPHS BY JOSÉ MANDOJANA

INFINITE VICTORY



When the difference between winning gold and going home empty-handed is measured in milliseconds, it pays to perfect every last detail. That's why the U.S. Olympic team tapped some of the brightest minds in tech for help before departing for Russia. When the athletes assemble beside the Black Sea in Sochi, here are a few of the breakthroughs that will help them chase gold.

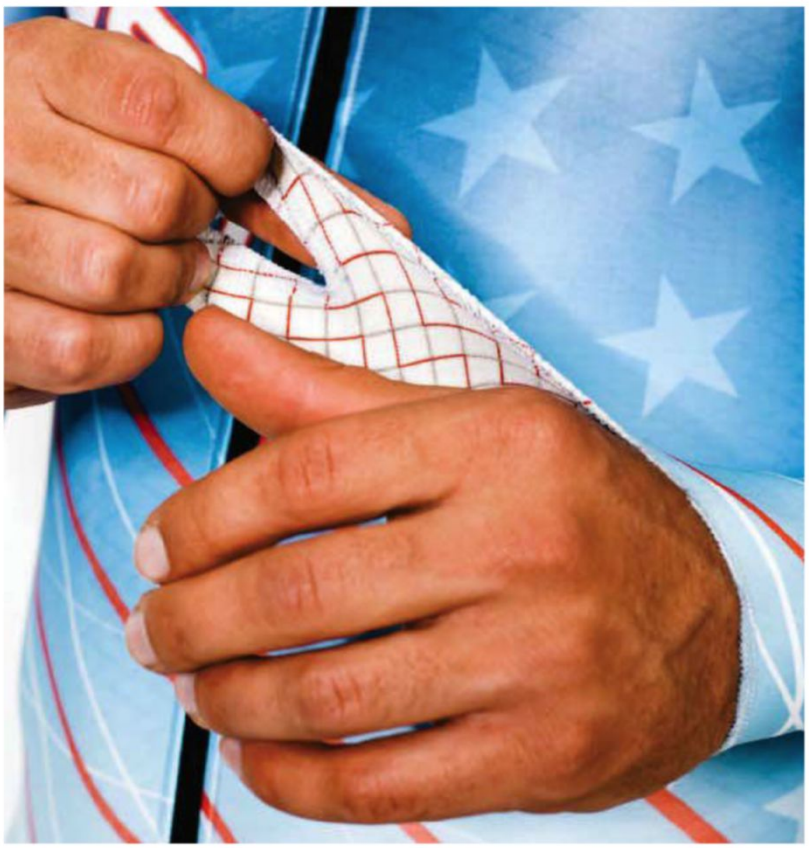
BY MICHAEL FRANK

Two-time Olympian (and Sochi hopeful) Steve Nyman perfects his form and tests his gear in Specialized bicycles' Morgan Hill, Calif., wind tunnel. The facility—outfitted with six 75-hp fans—measures the drag created by athletes and their equipment.



SKI SUITS

Spyder has been streamlining ski suits since the 1970s. The company's mid-'90s SpeedWyre technology—running the length of the arms and legs like the spoiler on a car—was so effective in reducing drag it was banned after two seasons by the sport's governing body. Today the company strives for a similar slipperiness by tinkering with yarn diameter, reducing the profile of padding and seams, and varying the textures imprinted on the skintight fabric. Textile choices play a role in safety too. As speed skiers have learned, if a suit isn't air-permeable, it can melt into the skin during the high-speed skid that follows a spill.



More Wearable Tech

Ski Boots
Ski racing requires precision as well as power. Fischer and Salomon have both developed boot shells that can be molded to match each athlete's foot and lower leg, dialing in control.

Ski Jumpsuits
To halt the rise of high-flying "squirrel suits," ski jump officials toughened the rules in 2011, mandating that the suits be skintight.

Skating Skins
Under Armour's speed-skating skins—developed with computational fluid dynamics expertise from Lockheed Martin—logged more than 300 hours of wind-tunnel testing.



HELMETS

For years a helmet's goal was to prevent skull fractures, but designers are now working on ways to fight concussions too.

The Giro Combyn helmet, worn by athletes including U.S. half-pipe-hopeful Gretchen Bleiler and already on the market for consumers, has a vinyl–nitrile liner and a flexible shell designed to withstand the multi-impact falls common in BMX, skateboard, and snowboard events. The materials remain pliable in the cold, transmitting less energy to the brain in the event of a wipeout.

Norway's Aksel Lund Svindal, the Super-G gold medalist in 2010, wears headgear featuring the Multi-directional Impact Protection System available in various brands. The shell has an inner membrane that slides during impact, dissipating the rotational forces unleashed on the head.

Aerial and mogul skiers will use technology designed by HIP-TEC, a company that creates sport-specific liners using data from rotational- and blunt-force crashes. The tech should be available for consumers this spring.



The Giro Combyn helmet endures an anvil drop test at the Easton-Bell Sports facility in Scotts Valley, Calif.

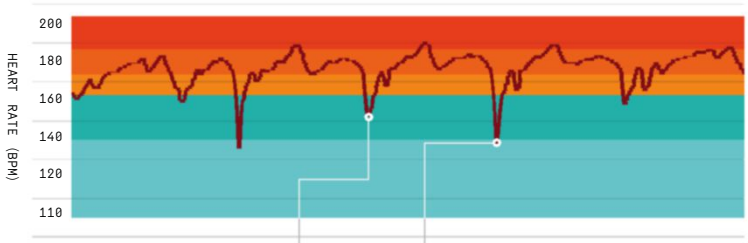
BIATHLON: SHOOTING

Few sports present the rigors of the biathlon. Competitors on skating skis must go from a heart-pounding sprint around the course to the preternatural stillness required to shoot at five targets—no bigger than the lids of beer cans—in rapid succession, without wasting a single bullet. Misfire just once and you earn yourself a 150-meter detour to the penalty loop or an extra minute on your time. Here's what happens on the firing range.

1. Firing Range

0–8 seconds: The athlete skis onto the range and dumps his poles.
9–12 seconds: The athlete unshoulders his rifle and assumes the shooting position—standing or prone.
13–22 seconds: With hips and shoulders square to the target, the athlete brings the rifle to his cheek and fires. The first shot is timed to the end of a heartbeat. In training, athletes use lasers to practice pulling the trigger for each successive target just as the sight crosses the plane of the bull's-eye. All five shots are fired within roughly 7 seconds.
23–32 seconds: The athlete dumps the spent clip (housed in the stock), swings the rifle onto his back, grabs his poles, and starts pumping away on his skis.

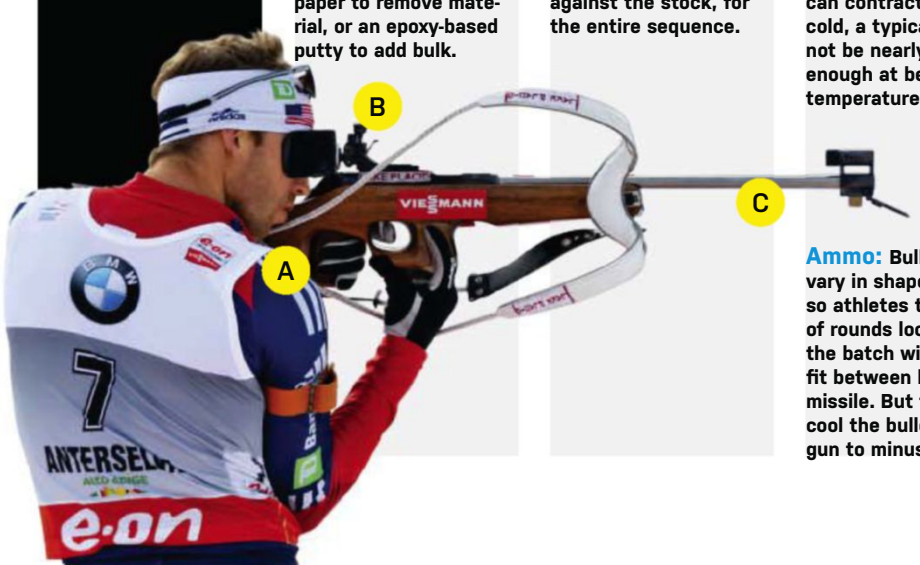
2. Heart of a Champion



SOURCE: TRAINING RUN OF AN ELITE U.S. BIATHLETE [ANONYMITY REQUESTED]

A biathlete's heart rate can plummet from 180 to 130 beats per minute in the time it takes to fire off five rounds. The deep troughs indicate the rate when shooting from a prone position. The shallower troughs were recorded from a standing position. One reason to fire quickly—besides the ticking clock—is that the drop in heart rate can cause muscle twitches, disrupting aim.

3. Anatomy of the Rifle



A. Stock The wood laminate may look retro, but it ably withstands shifts in temperature. It's also easy to customize. As athletes shed weight over the season, they rework the stock. The U.S.'s Lowell Bailey uses a Dremel and sandpaper to remove material, or an epoxy-based putty to add bulk.

B. Bolt While the bolt of a standard .22 requires a twist to lock and unlock, the bolt on a 3.5-kilo-minimum biathlon rifle operates via a simple push–pull action, allowing the athlete to maintain his aim, chest against the stock, for the entire sequence.

C. Barrel Made from the finest-quality steel—hence the $5000 price tag on certain rifles—the barrel is polished with a jeweler's precision, making it accurate in frigid conditions. Because the metal grain can contract in the cold, a typical .22 would not be nearly accurate enough at below-zero F temperatures.

Ammo: Bullets can vary in shape and size, so athletes test dozens of rounds looking for the batch with the best fit between barrel and missile. But first they cool the bullets and the gun to minus 4 F.

PHOTOGRAPH BY U.S. BIATHLON; ILLUSTRATION BY MARTIN LAKSMAN

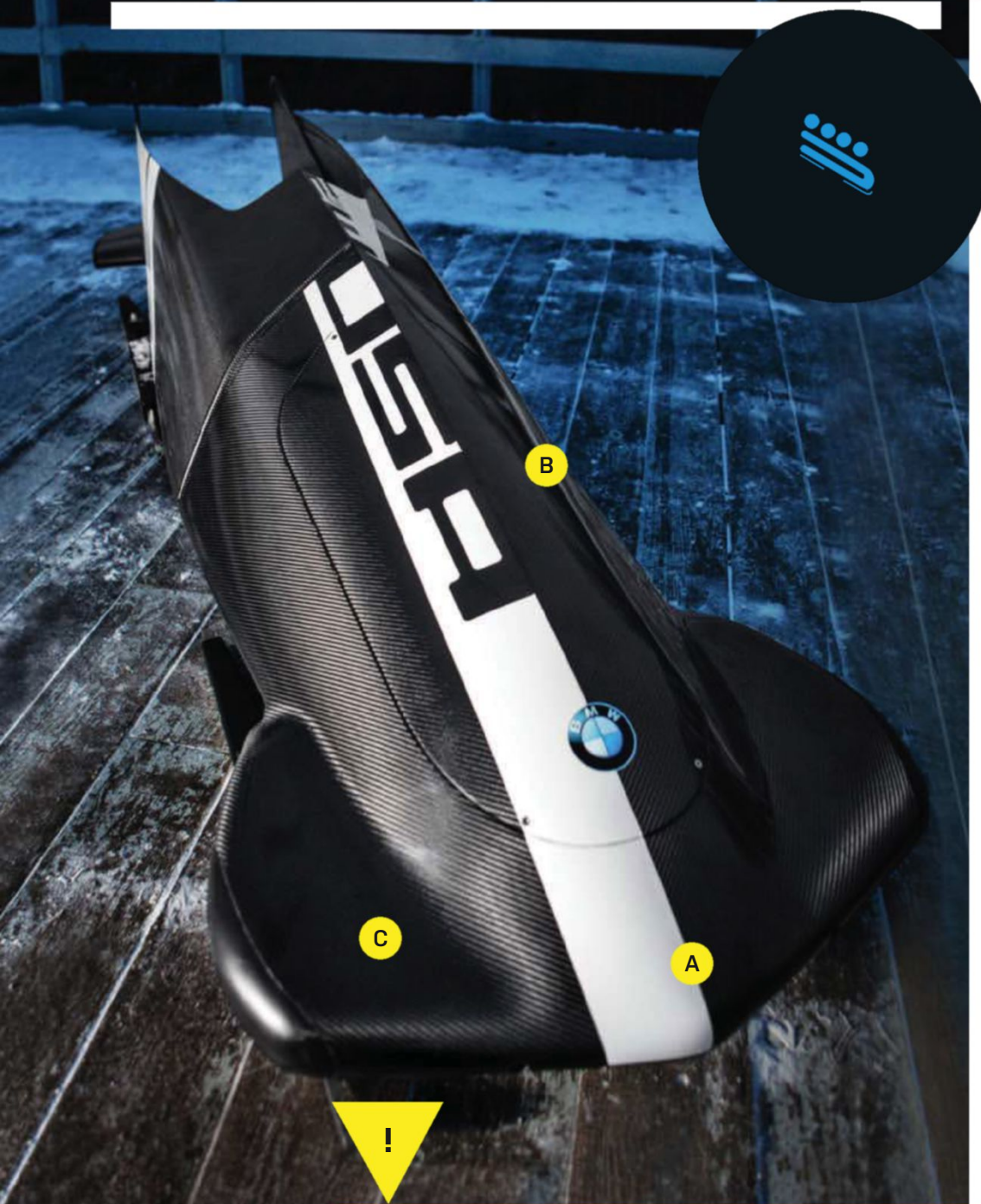
LUGE

The new sled's carbon-fiber chassis rests on state-of-the-art runners. To determine which metal composite performed best in varying temperatures, Dow Chemical's materials-science experts tested more than 20 options. The smoother ride cuts down on driver fatigue—no small plus given the grueling posture athletes adopt to remain aerodynamic.



BOBSLED

Michael Scully, a race car driver and car designer, recently led a BMW effort to redesign Team USA's bobsled. "Unlike a car, where braking g's or turning g's build up predictably," he says, "in a bobsled they ramp from zero to well over 5 g's almost instantly—they hit you like a hammer." Scully's team, based in California, focused on smoothing the ride—perhaps paving the way for the first U.S. medal in the two-man event since 1952.



A. Sleek The new carbon-fiber shell is slimmer than most, particularly up front, where BMW trimmed much of the bulk from the nose.

B. Fast The BMW design team used computational fluid dynamics to streamline the sled's skin to help it slice the air at the myriad angles experienced during a bobsled run.

C. Shifty While the sled's total weight is defined by regulations, designers can choose how to distribute it. BMW worked to lower the sled's polar moment of inertia, or resistance to turning on its long axis, which helps it move efficiently through the banking, twisting turns of the course.



The Mako hockey skate boot undergoes testing at the Easton-Bell Sports facility in Van Nuys, Calif. The goal: to withstand torsion forces through 500,000 cycles.



THE HOCKEY SKATE

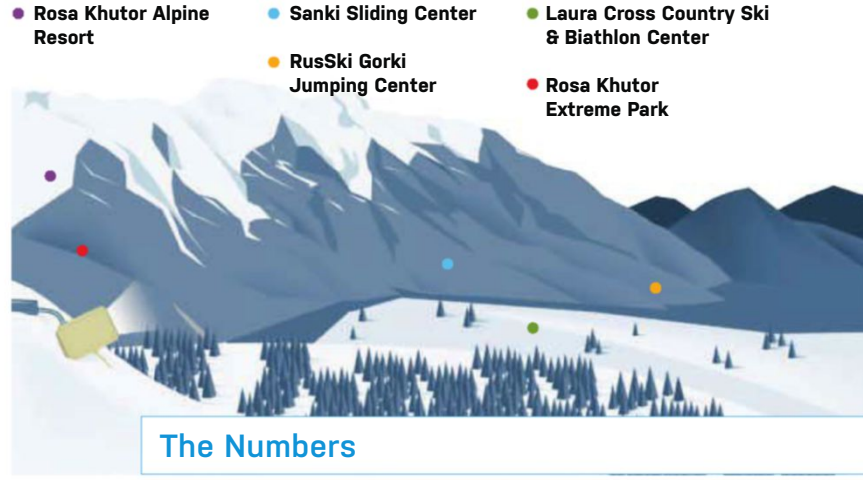
When four-time Olympic speed skater Dave Cruikshank first started teaching hockey players how to pick up the pace, he was dismayed to discover that their less-than-nimble feet were trapped in technology dating back to the sputnik era. "It was like watching them put snow tires on a Ferrari," he says. Inspired by the challenge, Cruikshank enlisted support from NHL legend Mario Lemieux and set to work on a skate upgrade. His masterpiece, the Easton Mako, has since been adopted by NHL stars Joe Pavelski, Erik Johnson, and Ryan Kesler. And now it will propel U.S. Olympians across the ice in Sochi. Thanks to the heat-moldable liners, the players no longer have to bind their feet with tape or cram them into small skates to get the snuggest fit. The blades tilt the skater forward onto his toes, somewhat in the manner of a starting block in track and field. And the hinged rear spine and pliable tongue make it easier to flex the ankle, allowing an athlete to drive completely through each stride and generate greater force—much like a 100-meter sprinter.

ILLUSTRATION BY MARTIN LAKSMAN

BIG CHILL

When lack of snow forced Sochi to cancel two World Cup ski events in February 2013, it sent a shiver down the spine of Olympic officials—and with good reason. An unexpected thaw in Vancouver, British Columbia, in 2010 compelled organizers to shuttle snow to the games via helicopter. And until recently, Sochi was best known as a palm-tree-laden summer retreat with average winter temperatures of around 50 degrees Fahrenheit. It is a favorite vacation spot of Vladimir Putin's (and, formerly, of Stalin's). The ski and snowboard venues lie nearly 30 miles inland, at up to 7600 feet above sea level, and normally receive ample snowfall. But the Russians have vowed not to rely on nature. With the help of Michigan-based SMI Snowmakers, they have assembled a high-tech battle plan: Workers can pump 12,151 gallons of water per minute up the mountainside to 403 snowmaking guns, all linked to SMI's software by fiber-optic cables. Just in case, though, the Russians also stockpiled snow last winter—16 million cubic feet of it—beneath giant thermal blankets. **PopMech**

Sochi 2014 Mountain Venues



The Numbers

Inconsistent snowfall isn't the only controversy surrounding the Sochi Olympics. Charges of corruption and environmental destruction have followed the run-up to the games, the most expensive in history—by far.

$51 BILLION
Cost of Sochi Winter Games

$43 BILLION
Cost of 2008 Beijing Summer Games

$7 BILLION
Cost of 2010 Vancouver Winter Games

THE IMPROBABLE FLYING MACHINES OF SYWELL

BY JEFF WISE

PHOTOGRAPHS BY REED YOUNG

TYPOGRAPHY BY JACKSON ALVES





PILOTS OF PEDAL-POWERED AIRPLANES DEFY PHYSICS TO COMPETE IN AVIATION'S MOST OBSCURE CONTEST. WELCOME TO THE ICARUS CUP; NO ENGINES ALLOWED.

"Dad! Hold the tail down!" David Barford shouts to his 73-year-old father, Paul, who shuffles along the grass while supporting a slender spar that connects the rear stabilizers to the cockpit and wings of *Betterfly,* a fragile aircraft that balances on two inline wheels. David's 20-year-old daughter, Charlotte, supports the starboard-wing spar with his best friend, Paul Wales. David's 17-year-old son, Chris, marches alongside the port wing, while David, 44, coordinates the action from

Team Betterfly guides its delicate aircraft across the grass of England's Sywell Aerodrome during the 2013 Icarus Cup.



the nose of the plane.

Team Betterfly's sense of urgency grows as the summer daylight fades and the sky west of Sywell Aerodrome, a rural airstrip 75 miles north of London, darkens prematurely with thunderclouds. It's the second day of the weeklong Icarus Cup, the world's most challenging human-powered-aircraft competition, and Barford wants to make a first attempt at the speed-course event. Two dozen spectators also anxiously monitor the weather, hoping the threatening rain doesn't ground the pilots.

The team gently sets *Betterfly* on the centerline at the end of Sywell's lone paved runway. To shed weight, Barford strips down to his underwear and bike shoes, and then eases into a red fabric pilot's seat made from two aluminum folding chairs. The only controls in the transparent cockpit are bike pedals and a handle for the rudder.

Barford calls out, "Three, two, one—rolling!" and begins to pedal furiously. The front-mounted propeller claws the air, and *Betterfly* starts gathering speed as it rolls down the runway. The crew supporting the aircraft walk, then jog, then sprint as the wings rise from their hands. *Betterfly* floats off the runway, 1 foot, 2 feet, a yard. Barford's legs churn. "Go, go!" Wales shouts. The nose dips precariously, sinking to within inches of the asphalt before slowly rising to an altitude of 6 feet; Barford then flutters down the runway at an airspeed of 18 mph. "The experience is quite odd," he says later. "You feel like you're just pedaling a bike, and then everything goes quiet because you're no longer in contact with the ground."

When *Betterfly* settles back onto the asphalt, the crew race up to support the wings, trailed by spectators on foot and bicycles. Barford has completed the 656-foot course in 42 seconds. He also earns duration points for remaining aloft a total of 62 seconds. With 1438 points, he's risen to second place, a mere 30 points behind the leader flying *Betterfly*'s nemesis, *Airglow*.

Human-powered flight,

dreamed of since the days of the ancient Greeks, was long considered to be impossible. Aeronautical engineers assumed that no airplane could be light enough to fly on such a limited power source—a pair of legs—and still be sturdy enough to carry a pilot.

Then in 1977, American aeronautical engineer Paul MacCready, capitalizing on breakthroughs in strong, lightweight materials, built a human-powered plane called the *Gossamer Condor*. After takeoff MacCready's pilot cleared an altitude of 10 feet, then flew a figure-eight pattern around pylons a half-mile apart in Shafter, Calif. The feat earned MacCready the £50,000 Kremer Prize, established in 1959 by British industrialist Henry Kremer. In



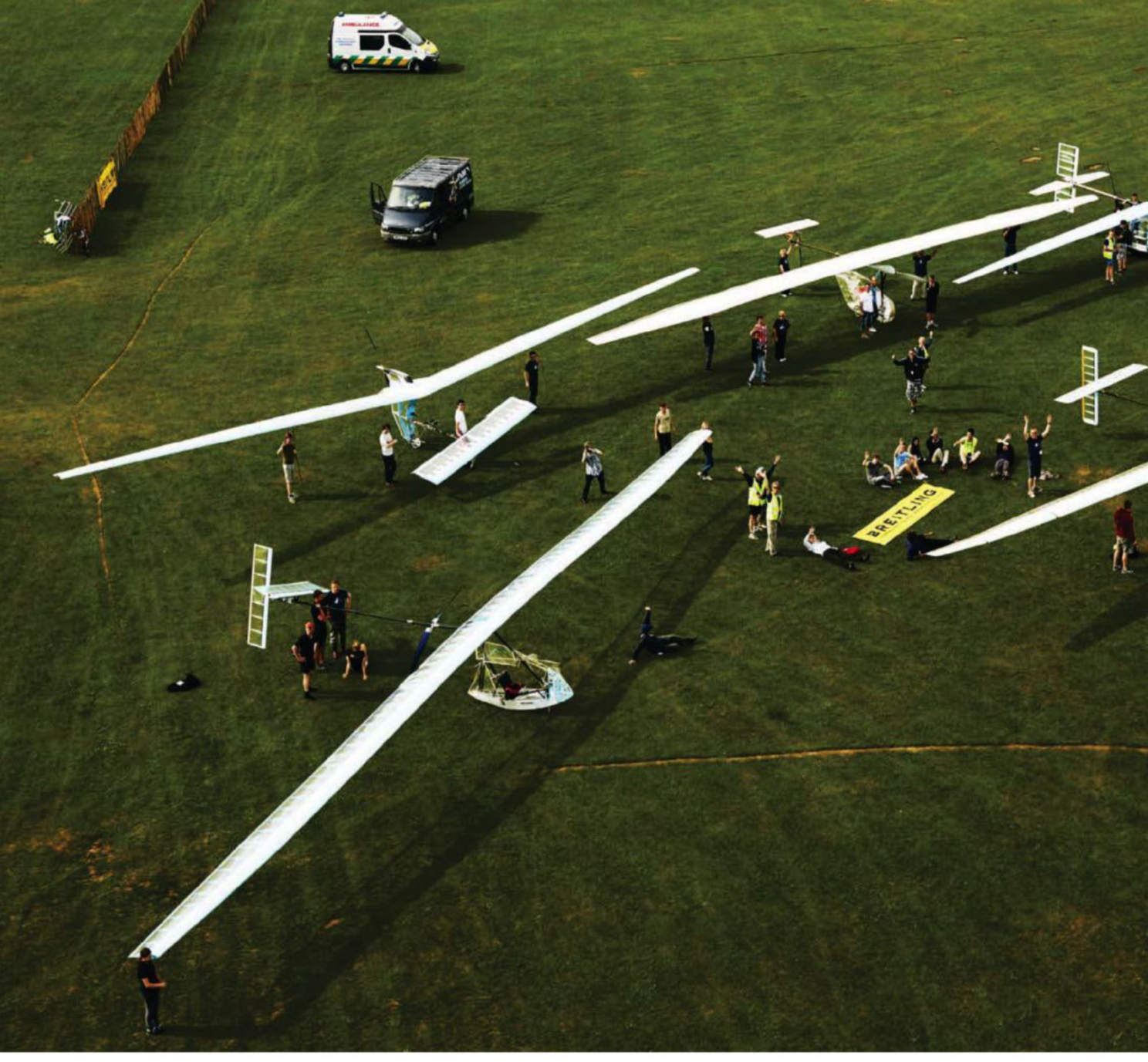
David Barford (center), best friend Paul Wales (left), and Paul's dad, Ray, repair the cowling of the *Betterfly* after a crash during takeoff. Barford built the craft in his garage and living room, to his family's occasional chagrin.

1979 MacCready's *Gossamer Albatross,* which used carbon fiber instead of aluminum, flew 22 miles across the English Channel in 2 hours 49 minutes.

After those accomplishments, the public lost interest in this esoteric corner of aviation. But David Barford did not. As a boy growing up in the town of Northampton, just 20 miles southwest of Sywell Aerodrome, he built model Gossamer Albatrosses out of cellophane and drinking straws. He left school at 15 to become an apprentice machinist at a race-engine-manufacturing company but never lost his fascination with human-powered aircraft. "They are a pure challenge," he says. "They demonstrate what can be done with so little power and the human mind."

With encouragement from other enthusiasts and support from his family, Barford decided to build his own pedal-powered airplane. He milled aluminum parts in the garage of his suburban home and made rib assemblies out of balsa and Depron foam in his living room, sheathing them with Dacron and Mylar.

He cannibalized the chain and bearings from a mountain bike and the wheels from his daughter's childhood bicycle. It took nearly eight years and $12,500 to complete the 88-pound *Betterfly,* which can fly on just 300 watts of power, compared with the 400 watts required by most human-powered aircraft—a power-to-weight ratio well-suited to the middle-aged, 5-foot 8-inch Barford, who holds no pilot's license. "I wanted to build it,"



Human-powered aircraft gather at the 2013 Icarus Cup. Of the four planes that competed, only two flew more than 1 minute. Organizers hope to turn this obscure hobby into a sport.

he says, "purely so I could fly."

As Barford was completing his plane, another enthusiast, Bill Brooks, chairman of Britain's Human Powered Aircraft Group of the Royal Aeronautical Society, was organizing a competition to showcase the country's pedal-powered fleet. He named it the Icarus Cup, after the Greek mythological figure who plunged into the sea after flying too close to the sun and melting his man-made wings. Brooks devised arcanely scored events to demonstrate the strengths of different designs: speed on straightaways, endurance on long hauls, and maneuverability on a tricky triangular course.

His real goal was to demonstrate that flying human-powered aircraft competitively could become an international sport. "I don't see that we'll all be flying to work in the mornings by pedal power," he says. "But what's wrong with a fascinating and interesting new sport? We hope to be in the Olympics one day."

The first Icarus Cup was held in 2012 at the home of the Lasham Gliding Society, 55 miles southwest of London, with five aircraft in competition: *Betterfly,* two craft built by universities, a plane built by professional aircraft designer John Edgley, and *Airglow*. Multiple pilots flew each plane; the pilot with the most cumulative points earned £2000 ($3100) and a small silver cup. Clearly, glory, not fortune, was the motivation.

Although *Airglow* flew four times as far as *Betterfly* and





Flight instructor and glider pilot Mike Truelove prepares for takeoff in *Airglow,* the aircraft that won the 2012 Icarus Cup. In this competition pilots double as engines.

topped the field, Barford had proved he could compete. His 500-yard flights were 10 times farther than he had expected.

This second edition of the Icarus Cup has been sanctioned by the International Air Sports Federation, and federation officials are mulling over the creation of a world championship in 2015. If that occurs, Brooks will have achieved his ambitious goal in a remarkably short time.

Meanwhile, back among Sywell's patchwork of wheat fields, hedgerows, and sheep meadows, Barford may be the hometown favorite, but the odds are against him. The same professional glider pilots who triumphed in *Airglow* at Lasham are keen to repeat last year's victory—Robin Kraike, who has 1000 hours in microlight aircraft, and Mike Truelove, who is a flight instructor. Both are in their 40s, lean, athletic, and a head taller than Barford. "I felt on top of the world," Kraike says. "That's what we came here to do, to win." The previous day, while Kraike and Truelove were racking up points for precise takeoffs, Barford was replacing adhesive tape and foam that mice had gnawed off his aircraft while it was stored in its travel trailer.

Physics does not favor human-powered flight. To lift a 150-pound pilot, an aircraft with *Betterfly*'s 355-square-foot airfoil and 75-foot wingspan requires around 0.55 hp to take off and about





0.45 hp to fly. Even well-trained athletes can only manage up to 0.5 hp in bursts, and 0.3 hp for extended efforts.

The aircraft competing for the Icarus Cup have comically long wings, but they need the length to fly. All wingtips generate swirls of air, or vortices, that disrupt airflow and produce drag. The longer the flight surface the smaller the effect of the vortices, and the less a pilot has to pedal to overcome drag and stay aloft.

Yet long wings also make an aircraft heavier, which demands more power from the pilot. Every ounce saved from the design counts for more air time and longer distances. That's why Barford flies in just his underwear in an airplane made of balsa, foam, and thin plastic. Another weight-saving omission: safety belts and harnesses.

Betterfly's wings, however, have tapered tips, "like a Spitfire airplane from World War II," Barford says. This wing shape minimizes induced drag and decreases the chance that air will separate at the wingtip during a turn, causing a stall.

All Icarus Cup entrants, even *Betterfly,* have trouble steering. Control surfaces on wings generate very little force at these sluggish speeds. Everyone crashes, and even low-velocity impacts produce major damage for these fragile aircraft. *Airglow* veers off course and breaks both wings piling into the multimillion-dollar *King Air*; *Betterfly* bungles a takeoff and cracks a cowling. Barford's son, Chris, steps on a wing and forces a nighttime repair to fix cracked spars, which is performed at Sywell under car headlights.



Barford secures victory on the last day of the 2013 Icarus Cup by flying *Betterfly* into the challenging triangular course.

The real Icarus competition becomes the repair marathon. Tool kits here contain wrenches and files for working with aluminum tubing, blue extruded Styrofoam, balsa, and resin. Around the tents and recreational vehicles of the team encampments stand large spools of replacement Dacron and Mylar that look like oversize rolls of Saran wrap.

Betterfly is not exactly the same aircraft that flew in the first Icarus Cup. The team has added fixtures to the wings that enable them to move forward on the fuselage, changing the plane's center of gravity. "That should allow us to fly slower with less drag," Barford says. But the first days of the competition are windy, and the team doesn't risk using the new design.

On the fifth day, when conditions are calm, Barford changes the wings' location and notches an impressive 102-second flight. But that achievement is quickly overshadowed by a successful 656-foot run by *Airglow*'s Truelove, which raises his score to within 26 points of Barford's first-place total.

Barford is visibly exhausted. His good-sportsman, we're-all-just-here-to-have-fun spirit has been overtaken by a gritty determination to win. The day ends with a lackluster 7-second fight. After Team Betterfly rolls the plane into the hangar, Barford slumps to the ground. "It's just not worth it," he says.

At dawn, Brooks announces that high winds and more rain will likely make this sixth morning's flights the last of the Icarus Cup. At 7:30 am Truelove takes off, rises quickly, and glides above the runway for more than a minute and a half, a personal best. The flight puts him in first place with a comfortable margin of nearly 200 points.

Now it's all up to Barford. His friends and family push *Betterfly* to the starting point and wait for the officials' all-clear signal. When it comes, Barford shouts to his crew, "Three, two, one!" *Betterfly* rises smartly but then drifts worryingly to the right. Barford straightens and stabilizes 6 feet off the deck. He's never flown so smoothly.

Then, halfway down the airstrip, the plane once again veers sharply. No pilot in the competition has made this kind of turn on purpose. The crowd stills, then cheers. Barford is heading into the intimidating triangle course. The crowd is shouting, "Go, David! Go, David!" Even Team Airglow is rooting loudly.

Barford completes the first leg of the triangle, and then makes the 60-degree turn. The course's tight corners are the ultimate test for *Betterfly*'s elliptical wings. The plane dips, rises a fraction, then settles onto the grass 102 seconds after liftoff.

The nose is practically resting on the white chalk line that marks the end of the second leg. "He's done it!" a marshal announces over the PA system.

Grinning, Barford climbs out of the cockpit and collapses on the grass as his team and spectators surround the aircraft. "I gave it everything I had," he pants.

After he pushes himself to his feet, Barford's father lets go of the wing spar long enough to give his son a hug. "I've only cried twice," Paul Barford says. "Once when you were born, and just now when you made that turn."

It will be hours before the rules committee awards 500 points to Barford, securing his position in first place. But with family, friends, and human-powered-flight fans celebrating at his side, he's already won. **PopMech**

Take the Disaster Prep & Survival Video Course Today

PREPARE *BEFORE* DISASTER STRIKES!

ON-DEMAND AT PopMechU.com

5 in-depth lessons

TO HELP YOU **PREPARE, SURVIVE & THRIVE** IN THE AFTERMATH OF A DISASTER, INCLUDING:

- Create a Home Backup Power Supply
- Stock a Budget-Friendly Disaster Pantry
- Safeguard Your Home; Clean Up in the Aftermath
- Protect Your Family with First Aid & Defense Tips
- Learn Chain-Saw Skills and Safety; Plus Step-By-Step Tree Takedown

PLUS COMPREHENSIVE DOWNLOADS, CHECKLISTS, WORK SHEETS **AND MUCH MORE!**



Watch Anytime ON-DEMAND Learn at Your Own Pace

GET $10 OFF
WITH DISCOUNT CODE: *SAVE10*

PREVIEW FREE TODAY AT PopMechU.com



Popular Mechanics

W weekend

DIY HOME
Eric Weil demonstrates the art and craft of making concrete furniture with a simple bench build. **p. 88**

TECH
Email is so much a part of our lives that we think we know all about it. Wrong. Here's the real deal. **p. 82**

HOME
The miter saw is versatile, inexpensive, and user-friendly. We test eight and pick the best. **p. 92**

AUTO
So, you just charge up your EV and go? Well, sort of. Learn the ins and outs of plug-in cars. **p. 96**

PHOTOGRAPH BY **GREGORY REID**



5 EMAIL MYTHS DEBUNKED

THINK YOU KNOW EVERY EMAIL TRICK? THINK AGAIN. *BY RACHEL Z. ARNDT*

We're all email power users, based purely on the hundreds, if not thousands, of messages we get each week. So it's easy to assume that we all know the best tips and tricks for managing that deluge: Keep your inbox lean, set up multiple accounts to stay organized, devise a strong password. It turns out that some of the conventional wisdom is outdated, and most of it is incomplete. Here's a rundown on those misconceptions and the best tools for making your email efficient—and secure.

NEON SIGN BY LITE BRITE NEON



MYTH: *The right way to deal with email overload is to clear out all your inbox notifications.*

REALITY: ***Folders, tags, and filters can be better organizational tools.***

There's a push lately to reach "inbox zero," which is exactly what it sounds like. That empty-inbox feeling may sound satisfying, but for someone who receives hundreds of emails a day, it may be more trouble than it's worth. So here's a compromise: an inbox that holds the messages you need to see but keeps them all easily searchable and structured, with distinct folders and tags. In other words, your messages are not entirely filed away; they are organized. "Rather than having all the emails in your inbox at once, crowding your focus, keep it lean," suggests Aye Moah, chief of product and cofounder of Baydin, the company behind the email add-on Boomerang. She's also a proponent of filtering your messages according to rules (parameters such as who the sender is or key words in the subject line) that require manual setup but then work on their own. Gmail, Outlook, and Yahoo all let you create rules and filters, either in settings or directly in the inbox. For instance, you might create a filter that finds all messages that contain "Bank of America" or "Citibank" and have a rule that automatically applies the label Finance. You can also create filters to tag every email from a certain sender or to automatically archive messages with attachments.



MYTH: *Setting up email aliases isn't worth the trouble.*

REALITY: ***Sure, it's a pain, but it could make your life easier.***

Aliases are different addresses that connect to your main account; they can help organize your inbound messages. They come in two forms: completely different usernames, and disposable email addresses with various separators between the base name and the tag. (Not every email service allows for both approaches.) Why create aliases? They can turn an address into something more professional-sounding, or group certain emails according to their purpose. For instance, my main email could be rachel@gmail.com, and rachel+shopping@gmail.com, an alias, could be the address I use with online retailers. I would still get all emails from retailers in my rachel@gmail.com inbox, but rachel+shopping@gmail.com would become a searchable term, which is useful. Additionally, if I had created a completely new username, such as rzashopping@outlook.com, to give out to online retailers, I could decide to delete it later to stop getting their emails.



MYTH: *Using a strong password will secure your email account.*

REALITY: ***A strong password is just the start. Use extra measures that probably already exist in your email system.***

Enable two-step verification. This adds a second factor to your password, usually a code sent to your phone. With that added layer of security enabled, every time you sign in, you'll have to check your

EXPERT TIP

TRICKS FOR THE BIG 3 OF EMAIL

GMAIL

- For about 5 seconds after you send a message, Gmail lets you unsend it. To enable the feature, go to Labs in Settings and enable Undo Send.
- Worried that you're signed in to your email on another computer but can't remember where? Scroll to the bottom of any gmail.com page, and look for the Details link under Last Account Activity. There you can see any open sessions and sign out everywhere at once.

OUTLOOK

- Right-click on a message in the inbox to reveal an Outlook-specific context menu, not just your browser's default menu. Below the standard items you'd expect to find—Reply, Forward, Archive, etc.—you'll see ones that are for a specific sender. Among these is Schedule Cleanup, which lets you automatically move or delete email from that sender after a set number of days. That way you'll only see more recent messages, reducing your overall inbox clutter.

YAHOO

- Perhaps the best secret feature in Yahoo is Not My Email, which the company launched after it began letting users claim dormant addresses. (The unintended side effect of that was people receiving messages not meant for them.) The button, which you can apply to messages without opening them, returns unwanted email back to the sender. Eventually, Not My Email also trains your system: If the subject line contains any hint that the email doesn't belong to you, you'll never see it surface.

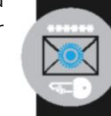
phone for the second key, which can be texted to you or retrieved in an app. It's slightly annoying but worth it. You can streamline the process by choosing to "trust" a specific computer; the system will require only a password and not the extra code if you are logging in from that machine. Additionally, application-specific passwords (strings of letters and numbers randomly generated by the email service itself) let you secure third-party applications that work outside a browser, usually on a different device, and which aren't compatible with two-step verification—such as Apple Mail, Android Mail, and Outlook. Then within your Settings page, you can manage the apps you've connected to your account. So if you lose your mobile device or stop using an app, you can simply remove access to the app to eliminate the security risk.



MYTH: ***You can only manage your email in real time, when you're in front of your computer or using your mobile device.***

REALITY: ***Add-ons can time-shift your email.***

Besides making it simpler to keep track of received messages, a supercharged email account can also make it easier to manage incoming mail. The key to that is getting emails only when you can deal with them. Of course, you can't expect everyone writing to you to wait until a designated time, but you can hide emails and have them automatically reappear when you want them to. "Email is a pretty old technology, relatively speaking," Baydin's Moah says, "and we haven't really come up with new tools to handle the load of email we're getting today." Her company's Gmail-only Boomerang plug-in does several things, but the primary use is to schedule outgoing emails to be sent later. Boomerang also has a snooze feature, like the one popularized by the Mailbox iOS app: The feature temporarily hides an email and pops it up in your inbox again at a set time, preventing emails from clogging your inbox until you know you'll be able to respond. You can also have Boomerang remind you to follow up on messages to which recipients have not yet responded. The snooze feature hides emails that you select; if you prefer to have all your emails come to you at a specific time, Inbox Pause (for Gmail only) will do the trick. It adds a Pause button to Gmail, which will hide your email until you choose to see inbound messages again.



MYTH: ***If Google wants to read your Gmail messages, there's nothing you can do to stop it.***

REALITY: ***Encryption can block outsiders, including your email provider, from snooping. (For more on digital security, see "Privacy," page 56.)***

Basic encryption through the HTTPS protocol comes standard in Gmail, Outlook, and AOL and can be turned on in Yahoo mail. But that only makes it harder for hackers to steal data as it moves between the email server and your browser. Micah Lee, a staff technologist for the Electronic Frontier Foundation, says, "The only way to truly keep your email private from email services themselves is to use OpenPGP email encryption." (PGP stands for pretty good privacy.) With free services such as Mailvelope (for Gmail, Yahoo, and Outlook), any recipient you send an encrypted message will have to enter a password to read it.



EPILOG LASER

LASER IT!

Engrave it. Cut it. Mark it.

NEW SYSTEM FUSION 40





MADEiNUSA

From creating and personalizing 3D models, to engraving photos on electronics, to marking auto parts and accessories, our laser systems create the products you see here and much more!

Desktop Systems Starting at $7,995

Contact Epilog Laser today for a laser system demo!

epiloglaser.com/popmech • sales@epiloglaser.com • 888-437-4564


✓Yes


✓Yes


xNo


✓Yes


✓Yes


✓Yes


✓Yes


✓Yes

✓Reliably Low Prices
✓Easy To Use Website
✓Huge Selection
✓Fast Shipping

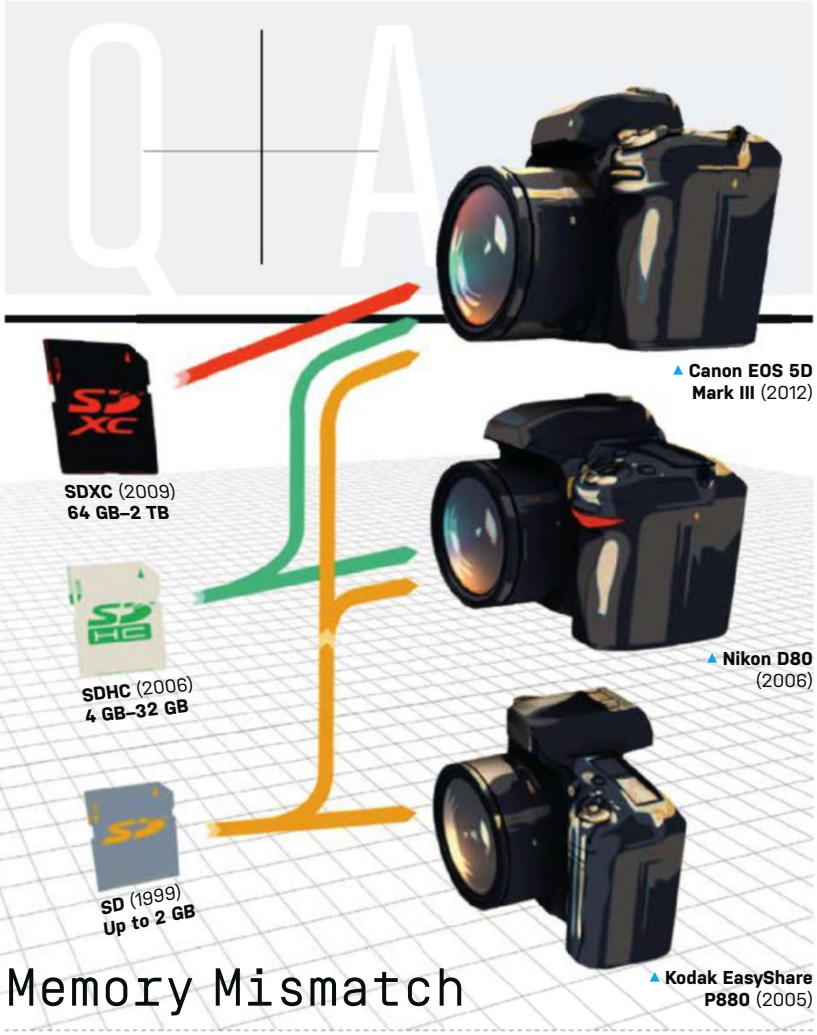
ROCKAUTO.COM

ALL THE PARTS YOUR CAR WILL EVER NEED

GO TO WWW.ROCKAUTO.COM ROCKAUTO, LLC (EST. 1999)

Digital Clinic

BY RACHEL Z. ARNDT ILLUSTRATION BY VIGILISM



Memory Mismatch

I put a 64 GB memory card in my camera, and when my camera tried to format it, I got an error message. When I went back to my old 32 GB card, it was fine. Is my 64 GB card bad, or is there a problem with my camera?

Neither, I'd guess. Your camera probably isn't equipped to read cards larger than 32 gigabytes. The larger cards fall under the SDXC standard, while cards between 4 and 32 GB follow the older SDHC standard. You can use SDHC cards in a device that reads the new SDXC cards, but the newer cards aren't backward-compatible. That's unfortunate, given their high capacities: Theoretically, the new cards could reach 2 terabytes, though now they max out at 256 GB. Even that's impressive. In the early 2000s, SD cards—which contained memory cells larger than 100 nanometers—could only hold a few megabytes. Today memory cells are one-fifth the size and store thousands of times as much data.

There is another difference between the two standards beyond their total capacity. SDXC cards are formatted in the exFAT file system, which allows for files of virtually unlimited size. (SDHC, which uses FAT32, can only record files up to 4 GB.) But that matters only if you generate huge files because you have a very-high-resolution camera (and a sensor to make that resolution worth it), or you shoot hours of video. Most files are much smaller than 4 GB.

Security Collision

I lost my computer. I have a password on it, and I also have tracking software. Will the password lock keep the tracking from working?

Your two computer-safety technologies—a login password and tracking software—may work against each other. Tracking software, such as Find My Mac for Apple computers and Prey for PCs, Macs, and Linux machines, requires you to be connected to the Internet to work. (Prey is the best option for PCs because it is nearly invisible on your computer, making it hard for thieves to disable.) Unfortunately, your computer won't get online unless you've logged in. So, if you have a password, you're out of luck. But in the future you can plan for the worst with a work-around: Create a limited-access guest account.

First make sure location services are enabled. On a Mac you'll find this in your Privacy setting.

Also turn on Find My Mac in the iCloud section of Settings. Then create a guest account without admin access, so that whoever logs in using that account won't have access to your files. As soon as the computer connects to the Internet, you'll be able to see it on a map on icloud.com and erase or lock it.

In Windows, enable location services in PC Settings. If you're using Prey, go to the site to mark your computer as missing. You might have to wait a few hours for the service to send you a digest, which includes the machine's location, along with a photo taken with the built-in camera, and a shot of what's on the screen. Prey will also display an alert on the missing computer that tells the user that the computer has been stolen and provides your email address; you can offer a monetary reward for the machine's return.

HBO No-Go?

I use my parents' HBO Go account in my apartment. Are there any legal issues I should be aware of? Will I get into trouble?

You probably won't catch any heat, although what you're doing is officially against HBO's terms. Whether you can share logins for any subscription site depends partly on the company's terms of service and partly on the Computer Fraud and Abuse Act (CFAA), which makes gaining unauthorized access to information—in this case, unauthorized access to TV shows—a misdemeanor. Some sites, such as Netflix and Hulu Plus, acknowledge in their terms of service that subscribers may share their passwords; Netflix limits the number of authorized devices to six and the number of simultaneous streams to two. If you exceed those numbers, an error message will appear.

HBO Go and Amazon, in contrast, prohibit password sharing in their terms-of-service agreements, and both allow only one device to stream at a time. Additionally, Amazon says you can't distribute any "digital content" to third parties, and HBO says that the only people who can legally use the service are those who subscribe to TV services that carry HBO. (HBO Go does allow subscribers to have three separate accounts so that household members can watch different shows at the same time.) Despite what the TOS says, it is rarely, if ever, enforced.

"The Department of Justice has taken the position that a violation of terms of service is criminal unauthorized access under the CFAA," says Kurt Opsahl, a senior staff attorney at the Electronic Frontier Foundation. But, he points out, the DOJ's position has been rejected by federal courts. And, he adds, "so far the service providers have not been particularly upset." To be really safe, you should check to see whether your state has any laws that specifically aim to curtail sharing video accounts. Tennessee, for example, passed the Web Entertainment Theft Bill in 2011, which makes it illegal to stream music and videos from paid services using logins that aren't your own. **PopMech**

? GOT A TECHNOLOGY PROBLEM? **ASK RACHEL ABOUT IT.**

Send your questions to **pmdigitalclinic@hearst.com** or over Twitter at @PopMechDigital or to Digital Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we can't answer questions individually, problems of general interest will be discussed in the column.



PHOTOGRAPHS BY **REED YOUNG**



BUILD A STONE COLD BEAUTIFUL BENCH

CONCRETE FURNITURE LASTS FOREVER, ESPECIALLY WHEN YOU BUILD IT LIKE A PRO.

BY DAVID AGRELL AND ERIC WEIL

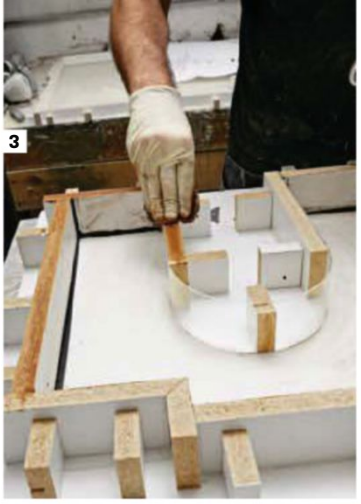
TOOLS & SUPPLIES

Concrete mix / sheet of ¾" white melamine particleboard / table and miter saws / hot-glue gun / 1/16" packing foam / shipping tape / black silicone caulk / paste wax / ⅜" rebar / calibrated mixing container / three 5-gallon buckets / 20-gallon trash can / electric drill / universal mixing paddle / 24" screed or float / trowel / hammer / 120-, 220-, and 320-grit sanding blocks / masking tape















Eric Weil (photo, previous page) once studied wood carving in Ghana, but nowadays it's the urban textures of New York City that inspire his work. Weil runs Brooklyn-based Oso Industries, which crafts furniture primarily out of concrete. It's a material he values for its appearance, adaptability, and strength.

We commissioned Weil to produce a bench project for PM readers that is less complicated than it looks: Three slabs combine with elegant through-tenon joinery, so you won't need any connecting hardware. The key is to fabricate accurate molds; then just mix up a batch of concrete and pour.

RECIPE: ERIC WEIL'S CONCRETE MIX

This time-tested mix sets smooth and hard and can be honed to a granitelike finish. Make two separate batches of this recipe: one for both legs, another for the bench top. Not ready for concrete alchemy? Pick up two 80-pound bags of Quikrete Pro Finish 5000 Concrete Mix instead.

20 lb Type I white portland cement	**30 lb** Multipurpose sand	**30 lb** Pea gravel	**77 oz** Cold water	**54 oz** Acrylic additive	**7 oz** Black alkali-resistant pigment

BUILD THE MOLDS

This bench relies on well-formed mortise and tenons for strength, so assemble the molds with care. Create them as you would a piece of furniture.

Make the sides and support blocks by ripping the melamine particleboard into strips with a table saw and cutting them to length with a miter saw according to the materials list on page 90.

Lay the remaining particleboard on a flat, level surface and use a pencil to trace the outline of the bench parts. Arrange the parts with enough surrounding space to allow for the support blocks.

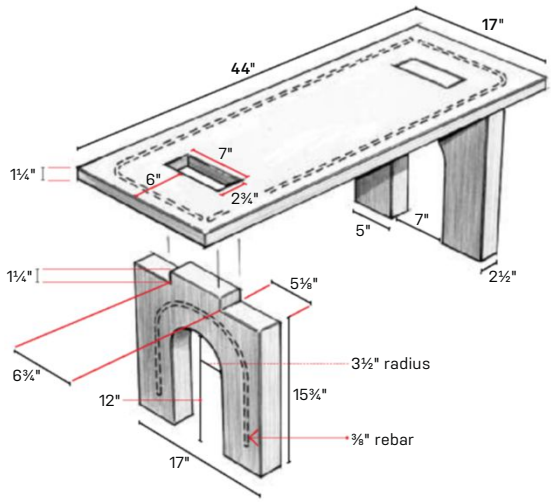
Attach the side pieces along the layout lines with hot glue. Miter the inside corners of the leg molds where the shoulders meet the tenons, then glue support blocks 4 to 6 inches apart around the perimeter of each mold **[1]**. To create the curved sections of the leg molds, install a block on the inside of each curve and bend plexiglass around it; make sure the straight sections of the plexiglass extend past the bottom of each leg.

The bench top's mortises are created from two rectangular knockouts. Assemble with hot glue, and wrap them in foam packaging material and a layer of shipping tape. This makes them easier to remove after the concrete has set; it also provides just enough wiggle room to make final assembly a snap. Trim the foam and the tape around the knockout **[2]**.

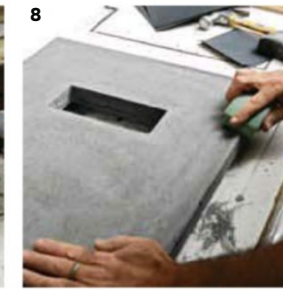
Next, apply caulk neatly along the seams. Black silicone caulk is easy to see against the white melamine and can be cleaned up with soapy water. Apply clear paste wax to all inside and top-edge surfaces **[3]**. Buff the wax with a soft cloth, but take care not to damage the molds.

PREPARE THE CONCRETE

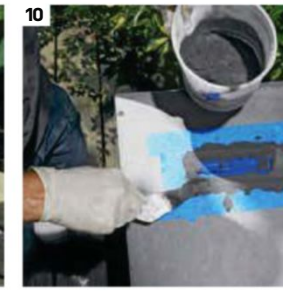
Concrete has excellent compression qualities, which means it's difficult to crush. However, it lacks tensile strength when used across




7


8


9


10

a span, so you'll need to reinforce your bench with rebar. Cut ⅜-inch rebar with bolt cutters, and bend the pieces into shape by hand or with a rebar bender.

Mix enough concrete to form both legs (see "Recipe: Eric Weil's Concrete Mix"). Many of the ingredients are toxic and irritate the skin, so wear a cartridge respirator, eye protection, and gloves. Use a calibrated mixing container to measure the cold water, acrylic additive, and pigment, and combine them in a 20-gallon trash can. Next, measure the cement and aggregates (the sand and gravel) into separate 5-gallon buckets. Add half the cement to the liquid mixture, and combine using an electric drill and a universal mixing paddle. Then add half the aggregates; mix well. Add the remaining cement; mix again. Add the remaining aggregates, and mix once more **[4]**. The concrete should have the consistency of yogurt.

Immediately pour enough to fill each leg mold to within 1 inch of the top, working it into the corners. Once the concrete starts stiffening, set the rebar into each mold **[5]**. Top up with the remaining mixture, screed the surface, and flatten with a trowel **[6]**.

Repeat for the bench top using the identical amount of concrete mix. Cover the parts with plastic sheeting, and leave to cure for a couple of days.

Qty.	Description	Material	Size
2	Sides for bench-top mold	¾" melamine	1¼" x 46"
2	Sides for bench-top mold	¾" melamine	1¼" x 19"
4	Knockouts for bench-top mold	¾" melamine	1¼" x 5½"
4	Knockouts for bench-top mold	¾" melamine	1¼" x 2¾"
4	Sides for leg molds	¾" melamine	2½" x 15¾"
6	Sides for leg molds	¾" melamine	2½" x 6¾"
4	Sides for leg molds	¾" melamine	2½" x 9½"
4	Sides for leg molds	¾" melamine	2½" x 2½"
4	Sides for leg molds	¾" melamine	2½" x 6½"
24	Support blocks for bench-top mold	¾" melamine	1" x 1"
46	Support blocks for leg molds	¾" melamine	2" x 2"
1	Backing sheet for all molds	¾" melamine	36" x 96"
2	Sides for curved sections of leg molds	1/16" plexiglass	2½" x 30"
2	Rebar for bench top	⅜" rebar	53"
2	Rebar for legs	⅜" rebar	34"

ASSEMBLE THE BENCH

Free the parts by knocking away the molds with a hammer **[7]**. Smooth everything with a sanding block, starting with 120-grit paper and moving toward 320-grit **[8]**.

Set the legs upright and squeeze silicone caulk onto the shoulders **[9]**. Get help positioning the bench top onto the legs.

Tape around the mortise and tenons, and fill the voids with a sanded grout mixture, adding pigment to match the bench color if desired **[10]**. After the grout has cured, remove the tape and clean with a damp sponge.



ILLUSTRATION BY GEORGE RETSECK

Everybody hates you.

You don't see bullying like this every day.

Your kids do.

Teach your kids how to **be more than a bystander.**

Learn how at StopBullying.gov

Ad Council

WAITT INSTITUTE FOR VIOLENCE PREVENTION

FREE TO BE... YOU AND ME
FREE TO BE FOUNDATION INC.

Tool Test



BEST OVERALL

MITER SAW

FEW WOODWORKING MACHINES match the versatility of today's 10-inch compound miter saw. These saws can cut framing lumber, furniture parts, trim, and crown molding. With a specialized blade, you can slice aluminum, copper tubing, or plastic pipe. We tested eight machines, cutting framing lumber and trim in both our shop and at a small remodeling job, plus plumbing parts on-site. We're pleased to report that all rigs received a rating of "good" (3½ stars) or better. Thrifty tool shoppers, rejoice: Dead-on woodworking accuracy can be yours for $120 to $300.

BY ROY BERENDSOHN

DEWALT DW713

RANKING ★★★★★

Price: $220

Max. cut at 90°, ¾ in. thick: 6⅜ in.

Max. cut at 45°, ¾ in. thick: 6⅜ in.

Likes: What do you need in a miter saw? Power? Check. Precision? Check. Attention to detail, such as just the right amount of tension in the spring hinge so the saw moves effortlessly into and out of a cut? Double check. Add to these excellent weight distribution and a broad stance.

Dislikes: Nothing.

CRAFTSMAN 21236

RANKING ★★★★

Price: $130

Max. cut at 90°, ¾ in. thick: 5¾ in.

Max. cut at 45°, ¾ in. thick: 6¼ in.

Likes: Beginners will find it a great and inexpensive machine. Experienced woodworkers and contractors will get good service from it as a backup or as an auxiliary to a larger, heavier saw.

Dislikes: The saw's base should be enlarged for cutting when the saw is not fastened to a support surface of some kind.

RYOBI TS1344L

RANKING ★★★½

Price: $120

Max. cut at 90°, ¾ in. thick: 5¾ in.

Max. cut at 45°, ¾ in. thick: 5⅛ in.

Likes: To be perfectly blunt, you can't beat this stone-simple saw for the money. It has enough power and accuracy for basic woodworking, especially with soft woods. Its miter table turns smoothly and locks firmly, and the laser line registers accurately across it.

Dislikes: The bevel gauge is tough to read.

PHOTOGRAPHS BY **GREGG DELMAN**



JET
JMS-10CMS

RANKING ★★★★½

Price: $300

Max. cut at 90°, ¾ in. thick: 5 15/16 in.

Max. cut at 45°, ¾ in. thick: 6⅛ in.

Likes: Jet (opposite, top) pulled out the stops with this saw—40 pounds of power and pro features. Contractors will like its robustness, even heavier than that of our first-place finisher. Its front-mount bevel lock and stable 13½-inch-wide stance enhance productivity.

Dislikes: It left a nub crosscutting a 4 x 4.

SKIL
3316

RANKING ★★★★½

Price: $120

Max. cut at 90°, ¾ in. thick: 5⅞ in.

Max. cut at 45°, ¾ in. thick: 6 1/16 in.

Likes: Left-handed users will appreciate the Skil's attention to their needs. It has dual triggers, one for lefties, one for righties. It's also a good generalist that's reasonably accurate. The miter table turns smoothly and locks where it should.

Dislikes: Tightening the miter-lock knob can slightly shift the miter table.

MAKITA
LS1040F

RANKING ★★★★½

Price: $210

Max. cut at 90°, ¾ in. thick: 5⅜ in.

Max. cut at 45°, ¾ in. thick: 5⅜ in.

Likes: This saw is sleek and powerful, with hair-splitting accuracy, and its internal blade-guard mechanism helps provide a clear sight line to your cut. Joseph Truini, a former carpenter and cabinetmaker, vouches for its work light: "Absolutely! Some work areas are quite dim."

Dislikes: Needs a wider base.

HITACHI
C10FCH2

RANKING ★★★★½

Price: $160

Max. cut at 90°, ¾ in. thick: 6⅛ in.

Max. cut at 45°, ¾ in. thick: 6 1/16 in.

Likes: Great saw, great price—that sums up the Hitachi. It cuts with power on a par with Makita and DeWalt and offers outstanding handle comfort, a heavy-duty work-support extension, a work clamp, and a folding auxiliary fence.

Dislikes: A broader base would help to increase stability and reduce rocking.

RIDGID
R4110

RANKING ★★★★½

Price: $200

Max. cut at 90°, ¾ in. thick: 5⅝ in.

Max. cut at 45°, ¾ in. thick: 5¾ in.

Likes: The Ridgid looks as if it should weigh more than its 30 pounds because its base is 15¾ x 20 inches. Yet this highly stable saw is easy to transport, thanks to excellent weight distribution and the best carrying handle of the bunch. Its 2¼-inch-diameter dust port is the largest among the saws we tested.

Dislikes: None.

Lubriplate®
No. 105 Motor Assembly Grease



It's A Tradition Because It Works!
The Original Prelube for Installed Engine Parts.
Provides Lubrication During Initial Start Up.
Prevents Scuffing, Scoring and Damage.

Also Try These Other High Quality Lubriplate® Lubricants.



Now Available Online at...
Lubriplate®.com
1-800-733-4755

Also Available At:
CARQUEST AUTO PARTS
For Store Locations
CARQUEST.com

Home Clinic

BY ROY BERENDSOHN AND DAVID AGRELL

Q+A

Before You Remodel, Look Up—Way Up

I just bought a house with a roof that has seen better days. The shingles are worn and cupped, and there's lots of rough-looking flashing. Anything I should worry about before I start interior repairs?



"The roof comes first" is an old expression, but it remains as meaningful as ever. The roof is your home's first defense against the elements, so don't tackle any interior remodeling projects until you evaluate what's above the eaves. "If the roof is bad, everything below it gets wet: walls, ceiling, insulation, electrical wiring, floors, carpets, furnishings, and heating and cooling equipment," says Jason Joplin, program manager of the Center for the Advancement of Roofing Excellence, which offers professional courses under the aegis of GAF, the nation's largest roofing manufacturer. "If any of this stuff stays wet, mold can form—and there's a real danger of structural deterioration."

If a roof inspection reveals problems serious enough to warrant repairs, the next step is to decide whether to fix it yourself or call a professional. In most cases it's

ICON BY JACK DYLAN

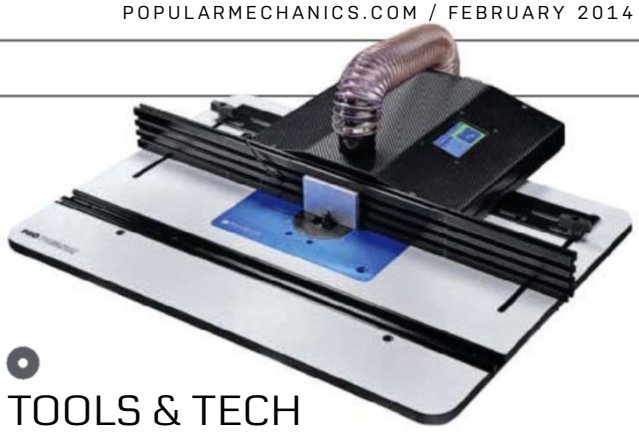
better and safer to hire a pro. Still, it's important to educate yourself before making the call so you know what to expect.

If your roof is shallow and low to the ground, and you're confident you can walk on it safely, climb up there and start inspecting. Watch your step and avoid low-hanging electrical cables. If it's too steep or high, inspect it from the ground using binoculars.

Start by checking the roofing material. Look for loose or missing shingles, as well as those that curl up, cup down, are chipped or torn, or have lost their granule coating. Generally, if more than one-quarter of the shingles are bad, it's time to replace them all. That can cost as much as $10,000, though the bottom line depends on the type of roof, its size, its pitch, and the number of valleys it has.

Next, inspect the roof deck for sagging areas that could indicate a compromised structure beneath. Then note any loose, damaged, or previously repaired flashing, and check the valleys for cracked roofing material. Look for severe weather deterioration or previous repairs around skylights, vents, and chimneys. While you're up there, check that the gutters are well secured.

Finally, head into the attic and inspect the underside of the roof deck. Mold or water stains on the plywood sheathing and the insulation could mean that moisture is coming in through the roof or that condensation is forming inside the attic.



TOOLS & TECH

ROCKLER READY2ROUT ROUTER TABLE FENCE ($599)

Though woodworkers have been bench-top manufacturing for centuries, Rockler's new router table borrows from the latest desktop manufacturing technology. It features a computer-controlled aluminum fence that automatically adjusts according to a program selected via a touchscreen interface. The system comes preloaded with apps for fabricating box joints, dadoes, half-blind dovetails, fluted columns, and beadboard.

WHY WE LIKE IT

The American-made Ready2Rout takes precision automation to a woodworking-specific and super-easy-to-use place. Most interestingly, it features a USB port for installing third-party apps, making it entirely hackable. The maker community will be all over this: Think custom moldings, multilayered inlays, and Escher-inspired joinery.

Generator Life Skills

Our standby generator has been working overtime this winter. Anything I should be doing to keep it from wearing out?

During long outages, check the generator's oil daily and avoid running it at full capacity. When possible, have the unit professionally serviced at the beginning of any outage that is expected to last more than a couple of days. "Most professionals inspect and change the appropriate filters, add fresh oil, and check the outputs," says Pat Porzio, an HVAC manager for Russo Brothers Plumbing in East Hanover, N.J. "A quality professional will also check the valve lash and spark plugs, which are often overlooked." Ideally, call for a service any time your unit logs 48 hours of continuous use. **PopMech**

? GOT A HOME-MAINTENANCE OR REPAIR PROBLEM? ASK THE EDITORS.

Send your questions to **pmhomeclinic@hearst.com** or over Twitter at @PopMechHome or to Home Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we can't answer questions individually, problems of general interest will be discussed in the column.

GLOSSARY

valley
The V-shaped intersection of two sloping roof parts. The roofing extends into a closed valley but stops short of an open valley.

flashing
Any impervious material installed around roof projections, such as chimneys, to direct water away from the joint.

blow-offs
Missing shingles torn off by high winds. This often indicates fastener or adhesive failure, or a loss of shingle flexibility.



DEGREE OF DIFFICULTY: 9/10
Unless you have ample experience with home electrical work, this is probably a task best left to a professional.

diy

Auto

STRANGE VIBRATIONS
SMARTPHONE SCAN TOOL
IGNITION TROUBLE

Saturday Mechanic:

HOME EV CHARGER BASICS

CONSIDERING AN ELECTRIC VEHICLE? YOU'LL NEED A 240-VOLT CHARGER TO GO WITH IT.

BY MICHAEL AUSTIN

Imagine never going to the gas station again. Such convenience is one of the key advantages of an electric vehicle, although it comes with two drawbacks: short range (sometimes less than 60 miles) and long charging times. Unless you can afford a $70,000 Tesla Model S, which goes up to 300 miles on a charge, there's not much you can do about an electric vehicle's limited range. But you can improve the charging time by installing a Level 2 (240-volt) charger at home. For a pure EV, a Level 2 charger cuts the time it takes to replenish the battery from more than 18 hours with a 110-volt wall plug to as little as 3 hours. And for plug-in hybrids it means that instead of tapping into the fuel tank, you can restore the car's electric range after you get home from work and before you head out for a night on the town.

According to Mike Mueller, product manager at Bosch, "If you know how to install a 240-volt dryer outlet, you can install an EV charger." However, he goes on to explain the maze of electrical codes that govern such an installation. Put simply, this is probably a job for a professional electrician. The good news is that when you buy an EV or a plug-in, many electric utilities offer incentives that cover the cost of a charger and its installation. So, hiring a pro to do the work not only is easy but also potentially free. This job will require an inspection—another reason for having the unit professionally installed. Here are the key things you need to know to get your house EV-ready.

Pick Your Charger

Aside from Teslas, EVs and plug-ins in the U.S. use the SAE-standard J1772 plug. Although they work about the same way, not all chargers are created equal.

Cost: Level 2 chargers range in price from just under $500 to more than $1000. The two biggest factors are amperage and cord length: If you want more, expect to pay more.

Installation Type: This unit is meant to be a permanent installation, mounted to the wall on a bracket. But some are classified (confusingly) as "permanently installed, removable" and use a standard plug so you can take the charger with you if you move.

Amperage: Level 2 chargers come in 16- or 30-amp flavors. A 16-amp charger works fine for plug-ins such as the Chevrolet Volt, which doesn't draw more current than that, and can often be installed with your existing wiring. But 30 amps should be your default, as it provides maximum charging speed and future-proofs your purchase if you buy a second electric vehicle.

Cord Length: The location of the charger in your garage will depend on how far you'll need to reach to access the car's charge



WHAT'S SO SPECIAL ABOUT THAT PLUG?

The SAE J1772 charging plug is as inelegant as its name. And the five ports that connect to your car might seem complicated, but they're actually pretty straightforward.

1. **AC power, just like the power plug for your TV.**
2. **Proximity detection. This is simply a mechanical switch that makes sure you're plugged in all the way.**
3. **Ground wire.**
4. **Communications, used to relay data between the car and the charger about how much current is needed.**

port. A Nissan Leaf, for instance, is about 14½ feet long and charges from the nose. We recommend a spot close to the garage door, so you can charge your car even if you're parked in the driveway. A 16- or 18-foot cord should be fine, but go longer if you can afford it. These units can't be retrofitted if you've left yourself short.

Get Your House Ready

The biggest potential headache with an EV charger is whether you have proper electrical service. If your house can't handle the extra load of a charger, you're dealing with an even bigger project of getting a new service drop, which means cutting off power to the house and installing a new meter and breaker panel. You'll also need to consider the age of your garage and its distance from the house. Old wiring going to the garage might need to be replaced, and longer distances can come with a nominal increase in the size and cost of the cable that runs to the charger. In most instances, though, an electrician will be able to properly wire to your garage. If you're experienced with home wiring, make sure you follow all the guidelines. Ignoring them carries a very real risk of an electrical fire. National Electrical Code Article 625 covers the rules for EV-charger installation, such as where a charger can be mounted and what kind of wiring is required. Check state and local codes as well.

If you don't have a garage, you can install a charger in your driveway. For outdoor mounting, you'll want a unit with a NEMA (National Electrical Manufacturers Association) rating of 4X—the Bosch Power Xpress is one example—which is made to stand up to rain, cold, and dust.

Car Clinic

BY BEN WOJDYLA

Q+A

Punishing Potholes

I was driving my Mazda5 to work when a pothole came out of nowhere. I avoided it with the front tire, but nailed it with the rear. Ever since there's been a faint vibration that I can hear and feel coming from that area of the car. Is there something wrong with my suspension?

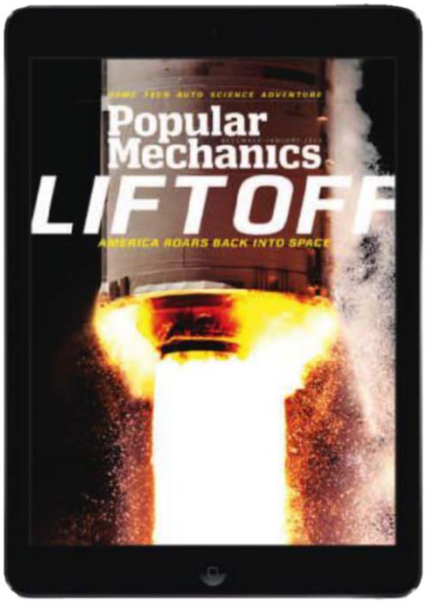


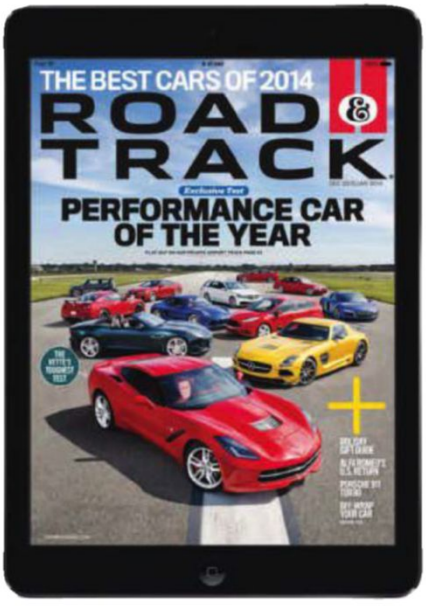
Potholes can viciously assault innocent vehicles—you're lucky it didn't swallow the car whole. Unless you were going extremely fast, though, there probably isn't any structural damage. It takes a pretty big hit to bend a piece of the suspension. Still, a pothole can do a number of bad things to the wheel and tire. It's most likely that vibration comes from a bent wheel rim. You should be able to see any damage on a close inspection; don't forget to check the inside lip of the wheel as well. Most steel and aluminum wheels can be repaired for less than $150 by companies such as Alloy Wheel Repair Specialists (awrswheelrepair.com), a mobile service that fixes wheels on the spot. In your case you can also buy a used factory-style wheel for about the same price. It's also possible that the impact knocked off one of the wheel balancing weights. And though it's unlikely, crashing your tire into a pothole can sometimes damage the steel belts inside, causing them to be out of round. After a quick look, take the car to a tire-and-wheel specialist for inspection and repair.

ICON BY JACK DYLAN

Got a new iPad?

Then now is the perfect time to treat yourself to all three magazines for just $5 a month!







If you received an iPad® over the holidays, or even if you didn't, you'll want to take advantage of the opportunity to get our best price on the digital editions of your favorite magazines:

Popular Mechanics
Trusted information and useful advice for your home, your car, and your life—plus the very latest in technology, engineering, digital privacy, tool tests, and more.

Road & Track
Your complete guide to everything automotive, where you'll gain insider access to the world's finest high performance and luxury vehicles.

Car and Driver
In-depth reviews on foreign and domestic cars, comparison and performance tests, award-winning writing, and stunning photography.

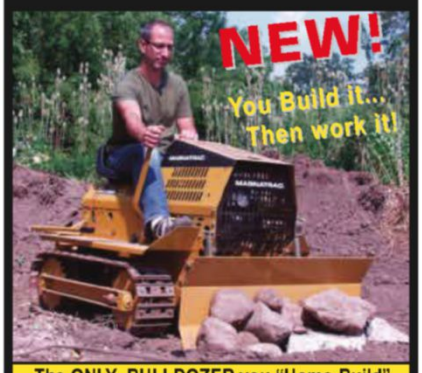
Get all three for only $5 a month... subscribe now:
deal1.hearstmags.com

Apple, Inc. is not a participant or sponsor of this promotion.
Apple, the Apple logo, iPad, and iPhone are trademarks of Apple Inc., registered in the U.S. and other countries.

Build Your Own... SCRAPPY DOZER

NEW!

You Build it... Then work it!



The ONLY BULLDOZER you "Home-Build" from a KIT! Plow snow, doze gravel, skid logs, grade driveways! Fits in the bed of pick-up!



Take the Next Step...CALL NOW!

877-828-8323

Use CODE - PM214

Only...$39 - Includes

- Assembly Manual
- $50 Refund Coupon
- FREE Action DVD

FREE SHIPPING!*

*Applies to manual purchase in USA.

19603

struckcorp.com/magnatrac-rs196k-order

UNCLOG DRAINS

with your Pressure Washer

100 Ft. Sewer Jetter ONLY $129

$10 OFF GIFT CODE: PM92

ClogHog.com

877.992.5644

Made in the USA

TerraTrike

PART OF THE SOLUTION

World's Most Comfortable Ride



Starting at $799

WWW.TERRATRIKE.COM

FREE CATALOG 800-945-9910

KINEKT GEAR RING

Interactive Jewelry For Men & Women.



Free Shipping & Lifetime Warranty.

Watch our video at

www.kinektdesign.com 888-600-8494

MATHTUTORDVD

Press Play For Success

Having Math Problems?

Yes

No

Earn A's with Ease

Get Help Now!

- Basic Math
- Pre-Algebra
- Algebra thru Calculus
- Differential Equations
- Physics
- Chemistry
- Probability/Statistics
- Calculator Tutorials

Begin Learning in Minutes! MathTutorDVD.com

- ✔ Raise grades or your money back
- ✔ Award Winning Courses
- ✔ Money Back Guarantee

Order By Phone: 877-MATH-DVD

View all courses online or order DVDs at:

MathTutorDVD.com

BURNTABLES

CNC Plasma Cutting On Edge



Dream It, Design It, Burn it

Start Your Own Business In Metal Art or Fabrication

COMPLETE TURN-KEY CNC TABLES

- Affordable Prices
- Industrial Grade
- Easy To Use



www.BurnTables.com

DR. COLOR CHIP

AUTOMOTIVE PAINT CHIP REPAIR SYSTEMS

Can Your Touch-Up Paint Do This?



BEFORE AFTER

Fast, Simple, Dramatic Paint Chip Repairs ...with NO PAINT BLOBS!



Step 1- Dab

Step 2 - Smear

Step 3 - Blend

- All Factory Match Colors
- Permanent Chip Repairs
- No Clear Coat Needed
- The Cure for Road Rash

3 kit sizes: $39.95 - $59.95

Rated #1 by *The Wall Street Journal* among do-it-yourself paint repair products

See our website for photos & video demonstrations

Order Your Paint Chip Repair Kit Today!

Drcolorchip.com (866) 372-2548



THE T-SHIRTS OF REAL AMERICAN HEROES

Join the club and get a new T-shirt every month representing a different group of specialized units from the U.S. Military, local and federal law enforcement, and fire departments.

ONLY $24 A MONTH

HeroTshirtClub.com

Stuttering hurts ...we can help!

800-992-9392 • www.StutteringHelp.org

THE STUTTERING FOUNDATION®

WOW!
It is AWESOME!

Our dust collection system is 100% better because our filters stay cleaner longer!
- D. Eilers



Super Dust Deputy
Only $169.00
Cyclone Only.

US Pat. #7,282,074
Design Pat. Pend.

Made in the USA
Oneida Air Systems
Like

Call for FREE Catalog!
800.732.4065

Order Online
www.oneida-air.com

Turn your Smart Device into an Ultra-Smart OBDII Diagnostic Tool.



The EasyDiag turns your Apple® or Android™ smart device into a powerful OBDII diagnostic tool with full system coverage for Reading & Clearing codes and Enhanced Live Data* with full graphing capabilities. The EasyDiag includes a Bluetooth® OBDII connector, along with OBDII Generic software. Customize your EasyDiag with additional software for over 30 manufacturers for Asian, European and Domestic Vehicles!

- Full OBDII Generic Code reader/scanner capability included at no charge!
- Reads and clears codes on all vehicle systems*
- Complete system and subsystem coverage* (Engine, ABS, SRS, Transmission and more) with live data and color graphing
- Enhanced live data for all vehicle systems*
- Includes Bluetooth® OBDII connector – it's all you need!
- Intuitive interface and easy to use prompts
- Customizable software – choose from over 30 Asian, European & Domestic manufacturers for enhanced capability
- Single carline software priced individually per vehicle manufacturer or purchase a custom 3 or 5 carline package
- Additional coverage, capabilities and functions with each new software update!

*With Manufacturer Software Download

MSRP $49.95

Made For iPod, iPhone, iPad and Android!

Software Available On The Apple App Store & Android Market

LAUNCH
The Global Leader in Diagnostics
ph: 1-877-LAUNCH9
For more information or to purchase contact your authorized Launch distributor.

www.launchtechusa.com

Finding Studs Just Got A Lot Easier.



- Highest accuracy stud finder
- Easy to use
- Find studs quickly and easily

The **Franklin Sensors ProSensor 710** has innovative stud sensing technology that instantly finds hidden studs. No sliding is required. It senses the wall in thirteen locations simultaneously, then immediately illuminates the LED lights in front of the stud. The ProSensor 710 is the fastest, least error prone, and most accurate stud finder on the market. It's the easy way to find studs.

FRANKLIN SENSORS
PROFESSIONAL STUD FINDERS
www.franklinsensors.com

Pajamagram

SPOIL HER this Valentine's Day!

Lots of hot styles and great packaging too!

FREE Gift Packaging with every order

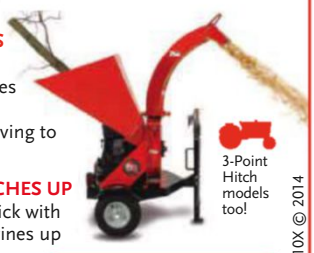


Shown: Hot Pink Lacey Chemise

It's a gift you'll BOTH love!

1.800.GIVE.PJS
PajamaGram.com

Save time and energy with a
DR® Rapid-Feed™ CHIPPER!



EFFORTLESS CHIPPING
Most branches will self-feed, instead of having to be force-fed.

CHIP BRANCHES UP TO 5-1/2" thick with powerful engines up to 18 HP.

DRchipper.com

81710X © 2014

WORLD'S FASTEST SPLITTER!



KINETIC POWER
The RapidFire™ uses twin cast iron flywheels (up to 75 lbs each) to blast logs apart in just one second!

ROAD TOWABLE
up to 45 mph!

DRLogsplitter.com

81711X © 2014

0%·36 MONTH FINANCING AVAILABLE
For details please call or visit online. Limited time offer.

Call for your FREE Catalog and DVD!
TOLL FREE 800-716-2567

6 MONTH HANDS-ON TRIAL
Try a DR on your own property for 6 months!

PHOTOGRAPHS BY **DEVON JARVIS**

Starting Out Stolen

My 2001 Chevy Malibu intermittently cranks, misfires, and sounds awful on start-up. After finally calling for a tow, it started perfectly at the repair shop and shows no trouble codes. What gives?

Malibus from the 1997 to 2003 generation have a Hall-effect sensor in the ignition switch that is notorious for going bad. When the switch wears out or the sensor goes out of calibration, the theft-prevention system thinks somebody is trying to steal the car. The scan tool you used was probably only for OBD-II diagnostics, which scans the industry-standard codes. A more sophisticated scanner (see Tools and Tech, this page) with GM-specific programming will more than likely find code B2960—ignition switch fault. Fixing it means replacing the ignition switch module and coding a new key. Unfortunately, at $200 to $300, it's a pricey fix.

Gas and No Go

My 2008 Hyundai Accent starts fine—except after fueling, when it needs several tries to fire up. It's a weird problem, and I hope you know the solution.

It's probably the purge control solenoid valve, which controls the pressure or vacuum in the tank. The evaporative emissions control system in modern cars contains and controls the fumes from evaporating fuel and prevents them from venting into the atmosphere. The fumes get trapped in a charcoal canister that later sends them to the engine under the right conditions. Too much pressure in the evap system and excess fuel vapor is pushed toward the engine, which won't start until the pressure equalizes. A replacement valve costs about $25, and is easily installed on some cars. **PopMech**



TOOLS AND TECH

ACTRON U-SCAN $80

The U-Scan is a new take on the traditional scan tool. It still hooks to the OBD-II connector under the dash, but instead of a crude display connected by a cord, the U-Scan connects wirelessly to your smartphone via Bluetooth. A simple interface makes it easy to check error codes, and in-app purchases expand what you can do. For $8 per car or $16 for unlimited use, you get manufacturer-specific codes and live data monitoring. ABS code reading can be had for $6 ($30 unlimited), and a database of common fixes costs $14 (or $40).

WHY WE LIKE IT

Even loaded with all the add-ons the U-Scan is a bargain compared to high-end scan tools, which cost around $200. And the U-Scan is easier to use. With no wires, you could even leave it plugged in all the time and use it as an extra gauge.

? GOT A CAR PROBLEM? **ASK BEN ABOUT IT.**

Send your questions to **pmautoclinic@hearst.com** or over Twitter at @PopMechAuto or to Car Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we can't answer questions individually, problems of general interest will be discussed in the column.

POPULAR MECHANICS (ISSN 0032-4558) is published monthly except for combined July/August and December/January, 10 times a year, by Hearst Communications, Inc., 300 West 57th Street, New York, NY 10019 U.S.A. Steven R. Swartz, President & Chief Executive Officer; William R. Hearst III, Chairman; Frank A. Bennack, Jr., Executive Vice Chairman; Catherine A. Bostron, Secretary. Hearst Magazines Division: David Carey, President; John P. Loughlin, Executive Vice President and General Manager; John A. Rohan, Jr., Senior Vice President, Finance. © 2014 by Hearst Communications, Inc. All rights reserved. Popular Mechanics is a registered trademark of Hearst Communications, Inc. Periodicals postage paid at N.Y., N.Y., and additional entry post offices. Canada Post International Publications mail product (Canadian distribution) sales agreement no. 40012499. CANADA BN NBR 10231 0943 RT. POSTMASTER: Send all UAA to CFS. (See DMM 707.4.12.5); NON-POSTAL AND MILITARY FACILITIES: send address corrections to Popular Mechanics, P.O. Box 6000, Harlan, IA 51593. Printed in U.S.A.

EDITORIAL AND ADVERTISING OFFICES: 300 West 57th Street, New York, NY 10019-3797.

SUBSCRIPTION SERVICES: Popular Mechanics will, upon receipt of a complete subscription order, undertake fulfillment of that order so as to provide the first copy for delivery by the Postal Service or alternate carrier within 4 to 6 weeks.
>>> Subscription prices: United States and possessions: $24.00 for one year. Canada and all other countries: $40.00 for one year.
>>> Should you have any problem with your subscription, please visit service .popularmechanics.com or write to Customer Service Department, Popular Mechanics, P.O. Box 6000, Harlan, IA 51593. Please enclose your mailing label when writing to us or renewing your subscription.
>>> Popular Mechanics is not responsible for unsolicited manuscripts or art. None will be returned unless accompanied by a self-addressed stamped envelope.

MAILING LISTS: From time to time we make our subscriber list available to companies who sell goods and services by mail that we believe would interest our readers. If you would rather not receive such mailings, please send your current mailing label or exact copy to Popular Mechanics, Mail Preference Service, P.O. Box 6000, Harlan, IA 51593.

AS A SERVICE TO READERS, Popular Mechanics publishes newsworthy products, techniques, and scientific and technological developments. Because of possible variance in the quality and condition of materials and workmanship, Popular Mechanics cannot assume responsibility for proper application of techniques or proper and safe functioning of manufactured products or reader-built projects resulting from information published in this magazine.

PopMech

Classified Ads

To Reach 9 Million Prospects each month

or for additional advertising information, call Kathleen Gleason at *708-352-8430,* or e-mail: klassmark@aol.com.
THANK YOU for choosing Popular Mechanics Classified Advertising, 512 West Burlington Ave., LaGrange IL 60525.
For subscription questions, visit service.popularmechanics.com.

ARTS, CRAFTS, SUPPLIES

WHOLESALE PRICES ON JEWELRY CRAFT ITEMS, Beads & Beading Supplies, Rockhound Supplies, Belt Buckles, Clock Movements. Free 122 page catalog: **Eloxite:** Dept. 45, Box 729, Wheatland, WY 82201, **Ph.: 307-322-3050 Web: www.eloxite.com**

AUTOMOTIVE

AMSOIL, SYNTHETIC LUBRICANTS. Buy Direct, Register to Buy Wholesale. **Free Catalog**. 1-888-450-2658. **www.synthoils.com**

INSTANT READING DIPSTICK extracts oil inside sight tubing w/o Reinserting! **www.looktoOHHO.com**

JEEP WRANGLER AND CJ RUSTY FRAME REPAIR KITS. Fix the worst frame rust quickly, every kit has 30 years experience, to order call **1-800-407-7024** or visit: **SAFE-T-CAP.COM**

FULL MOTION RACING SIMULATOR KITS FROM $1889.
DIY MOTION SIMULATOR KITS FROM $1,281.
USE THE SAME HARDWARE AND SOFTWARE PROFESSIONALS USE TO TRAIN LIKE A PRO IN YOUR OWN HOME.
WWW.SIMXPERIENCE.COM

BICYCLES

GOLDEN EAGLE BICYCLE ENGINES 2 & 4 Cycle Geared Belt 25 - 40cc **517-410-2793 bikeengines.com**

BOATS, OUTBOARDS, TRAILERS

BOAT KITS - PLANS - PATTERNS - SUPPLIES Catalog $5.00, Clarkcraft, 16-6 Aqualane, Tonawanda, NY 14150. 716-873-2640. **www.clarkcraft.com**

AS SEEN ON NCIS! BUILD YOUR OWN BOAT - Send $9.95 for Book of Designs, includes free plans. Glen-L, 9152 Rosecrans/PM, Bellflower, CA 90706, 888-700-5007 **WWW.GLEN-L.COM/PM**

BUSINESS OPPORTUNITIES

PROCESS MAIL FROM HOME! Excellent weekly Income. For free information send S.A.S.E.: MAILERS - PM, P.O. Box 458, New Britain, CT 06050-0458

DO-IT-YOURSELF

HYDRAULIC JACK REPAIR - Manual and catalog: $15.00 **620-594-2247**, HYDRAULIC PARTS SUPPLY, P.O. BOX 97-PM, Sawyer, KS 67134.

ELECTRONICS

PRINTED CIRCUIT BOARD DESIGN Schematic, Layout, Packaging, Fabrication and Assembly. Reverse Engineering. Prototypes to Production. Your one stop solution! **www.PCB3D.com**

HEARING AIDS

HEARING AIDS - GUARANTEED LOWEST PRICES! No huge commissions. Home trial, terms. All makes. We're the oldest, biggest, best. Custom instrument specialists. Free information, **1-800-323-4212.** Lloyds-PMC

DIGITAL HEARING AID SALE 16 channel bands, any size, any type or BTE $339.95 Options: touchtone, twin mics, custom molded - $50.00 **New! Open Fit Technology - most brands - big discounts** Repairs $77.00 (since 1981) Free brochure & mold kit **Hearing One 1-800-249-4163** 100 Main Street, Marty SD 57361

TROUBLE WITH YOUR HEARING AID? Lilli Electronics is a full service hearing aid repair lab. We can quickly return most hearing aids to perfect, working condition. Serving the U.S. and beyond since 1967. Call: 1-800-653-8882 or visit us at: **lillielectronics.com**

FREE HEARING AID CATALOG! PRICES START AT $249.00 ! Lowest Prices ! Huge Discounts !All Makes ! Trial Period ! **Monroe Hearing Aid Corporation** P.O. Box A-3976, Chicago, Illinois 60690 **1-800-462-5778**

HELP WANTED

$400 WEEKLY ASSEMBLING Electronic Circuit Boards/Products. Rush S.A.S.E.: Home Assembly - PM, P.O. Box 450, New Britain, CT 06050-0450

Make $500 Weekly. E-Z Assembly Work Free Information, Send SASE: JDK-P, Box 635, Hopkins, MN 55343-0635

METALS

NEED METAL? Aluminum, Steel, Stainless, Brass No Minimum order, quick shipping. **www.Industrialmetalsales.com** Phone: 586-783-2238.

OF INTEREST TO ALL

FREE CATALOG by mail. Meet nice singles, women, men. Photos. Profiles. All ages. Since 1981. Box 310, Allardt, TN 38504. Call **931-879-4625.**

FULL LINE INDUSTRIAL DISTRIBUTOR TECHNICAL INFORMATION ON LARGE INVENTORY OF INDUSTRIAL SUPPLIES! "CLICK" ON ITEMS FOR DETAILS! FREE CATALOG! 800-525-8665 WWW.TSTOOL.COM

OF INTEREST TO ALL

UFOs? ALIENS? Possible Commercial Trade? Write: Star-Land SPACEPORT, 4230 SE King Road #291, Milwaukie, OR 97222 - **spaceark@gorge.net**

JESUS WHO? Old Cherokee: Tsey-Tsu! Consider the Traditional Beliefs of Our Tribal Fore-Fathers. Write: POPULAR JESUS, 4230 SE King Road #291, Milwaukie, OR 97222 - **rchapel@gorge.net**

OF INTEREST TO MEN

ASIAN BRIDES! Worldwide! Free Details/Photos! PIC, Box 4601-PM, T.O., CA 91362. **805-492-8040. www.pacisl.com**

SATELLITE SYSTEM

COMPLETE DIGITAL SATELLITE TV Dish System / Free Channels - No Contract or Monthly Bill, Watch FREE 200+ Channels Call 574-233-3053 for **FREE Satellite Chart and Information Package. www.rcdst.com**

SONGS & POEMS

SONG HOUND MUSIC Your Lyrics or Poems set to any style of music by **NASHVILLE MUSICIANS**. Simple or full production arrangements. Box 58144, Nashville, TN 37205. **615-353-3880. www.songhoundmusic.com**

TREASURE FINDERS

BURIED TREASURE – SENSITIVE EQUIPMENT ALLOWS LOCATING FROM DISTANCE. Brochure free. SIMMONS, Box 10057-MA, Wilmington, NC 28404 **www.simmonsscientificproducts.com**

WANTED TO BUY

BUYING GOLD, SILVER, PLATINUM - ANY FORM 60 years experience. Free pricing quotes. Top payment. **1-800-932-1010 www.preciousmetalsreclaiming.com**

WATER PURIFIERS

Drinking Water Scams EXPOSED! Free Reprt ($15 Value) & Catalog. Which Water is Best for You? **800-874-9028 ext. 652 waterwise.com/pm**

WINE/BEER MAKING

WINEMAKERS - BEERMAKERS. Free Catalog. **(800)841-7404.** KRAUS, 7850-L, Independence, Missouri 64054. **www.eckraus.com/offers/L.asp**

A Brief History of the . . .

Tunnel

Tunnel building may be boring, but it's never dull! From spoons to high-tech TBMs, we dig into the long, winding story of the tunnel. BY AMANDA GREEN





2180–2160 B.C.: Babylonians dig a 3000-foot-long tunnel under the Euphrates River.

1681: France's 515-foot-long Royal Canal in Languedoc is inaugurated; its tunnels were blasted using gunpowder.



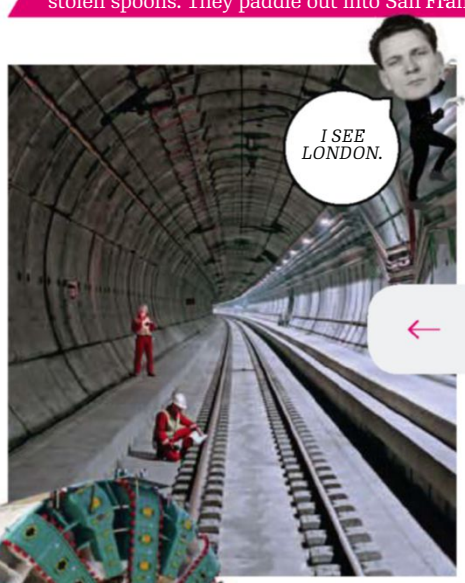
1867: Tunnel construction booms when Swedish engineer ***Alfred Nobel*** (yes, that Nobel) patents dynamite.

1927: The Holland Tunnel uses a ventilation system to remove exhaust. On either side of the Hudson River, 84 fans in four buildings change the tunnel's air every 90 seconds.

1952: James S. Robbins comes up with a dam good idea and designs the modern tunnel-boring machine (TBM) for South Dakota's Oahe Dam project.



1962: Inspired by a PopMech issue, three Alcatraz inmates escape through a tunnel they dig with stolen spoons. They paddle out into San Francisco Bay on a makeshift raft and are never seen again.



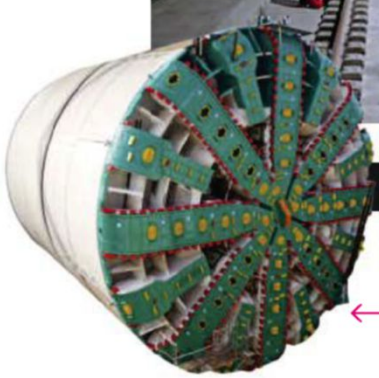
1963: In *The Great Escape,* which is based on a true story, prisoners escape from a German POW camp by digging three tunnels they name Tom, Dick, and Harry.

1988: Japan's 33-mile-long Seikan Tunnel, the world's longest and deepest railway tunnel (787 feet below sea level), connects the islands of Honshu and Hokkaido. Alas, many time- and cost-conscious travelers stick to flying.

1994: After 192 years of planning and six years of building, the Channel Tunnel runs under the English Channel, connecting England and France. With a price tag of $21 billion, it's the costliest construction project to date.

2005: Smugglers dig a 360-foot-long tunnel from a Quonset hut in Canada to the living room of a house in Lynden, Wash. Police admire its lights, ventilation, and concrete floor.

2010: New York City turns on the first TBM for the Second Avenue Subway line, a project 81 years in the not-making. Builders later use cut-and-cover and drill-and-blast methods.

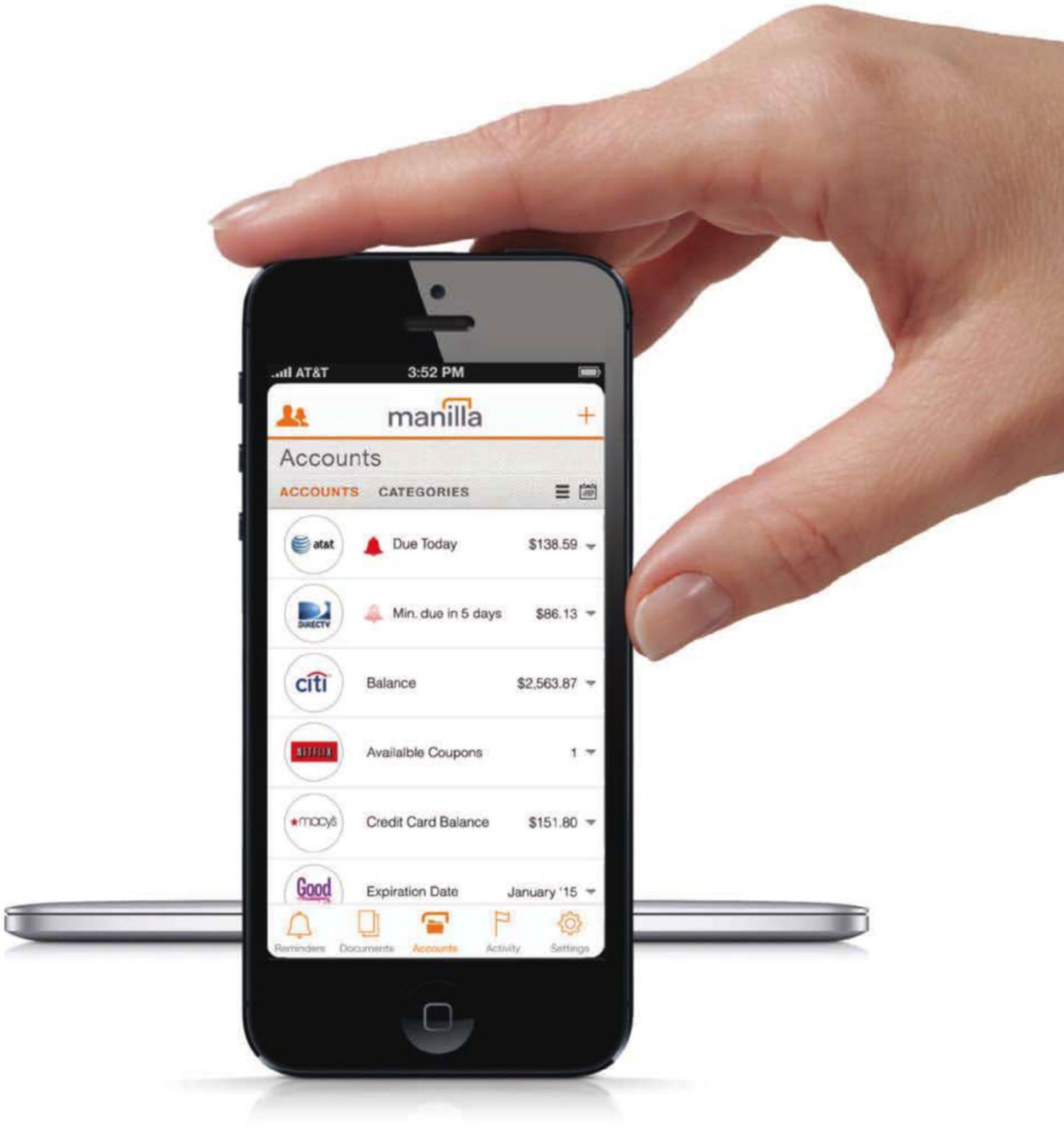




2013: The world's largest TBM, at 7000 tons and 57.5 feet wide, begins a tunnel to replace Seattle's Alaskan Way Viaduct. It will be the widest in North America.



PHOTOGRAPHS BY GETTY IMAGES (FRENCHMAN, BLASTING SWITCH, DYNAMITE, NOBEL, HOLLAND TUNNEL, STEVE MCQUEEN), THOMAS REUTERS (ALCATRAZ ESCAPEES), ALAMY (CHANNEL), WSDOT (TBM)



Get a Hold of Your Finances

FREE | ONE PASSWORD | SECURE

UNLIMITED DOCUMENT STORAGE | AUTOMATIC ORGANIZATION

HEALTHCARE ACCOUNTS | BILL SHARE FEATURE

manilla.com

Everything In One Place™

★★★★½ ★★★★½

EXCITES THE HEART, SENSES AND NOW, HANDS.

Stay in touch when you're on the road with Infiniti InTouch™*—an intuitive, touch-screen, dual-display system inside the Infiniti Q50. Infiniti InTouch hosts a wide range of social, music and utility apps that synchronize with your smartphone to seamlessly keep you up-to-date with your life. Now that's truly liberating.

The all-new Infiniti Q50 with Infiniti InTouch.



THE ALL-NEW INFINITI Q50

Join us at InfinitiUSA.com/Q50

INFINITI.

INSPIRED PERFORMANCE™

*Driving is serious business. Only use Infiniti InTouch Apps™ services when safe to do so. Subscription Agreement required. Compatible smartphone required. Late availability. May require retailer service visit or software upgrade to activate. Not all app features are available for all models. Like any computer, processing speed may vary and system response delay or system reset may occur intermittently. Never program while driving. GPS mapping may not be detailed in all areas or reflect current road regulations. Cellular network not available in all areas. Cellular network, apps and services, including Google® services, are provided by independent companies not within Infiniti's control and may require subscription and owner consent to activate. Should provider terminate/restrict service, service may be terminated without notice or liability to Infiniti and/or its agents. Infiniti not responsible for any equipment or app replacement/upgrades, or associated costs, that may be required for continued operation. Terms and conditions of Subscription Agreement apply. 48-mo. trial period starts on vehicle sale date; subsequently a paid subscription is required at the then current rate. Standard text rates and/or data usage may apply. See retailer and www.infinitiusa.com/intouch/support for details. Always wear your seat belt, and please don't drink and drive. ©2014 INFINITI.